JADS JT&E

Joint Advanced Distributed Simulation

Joint Test and Evaluation

Program Test Plan

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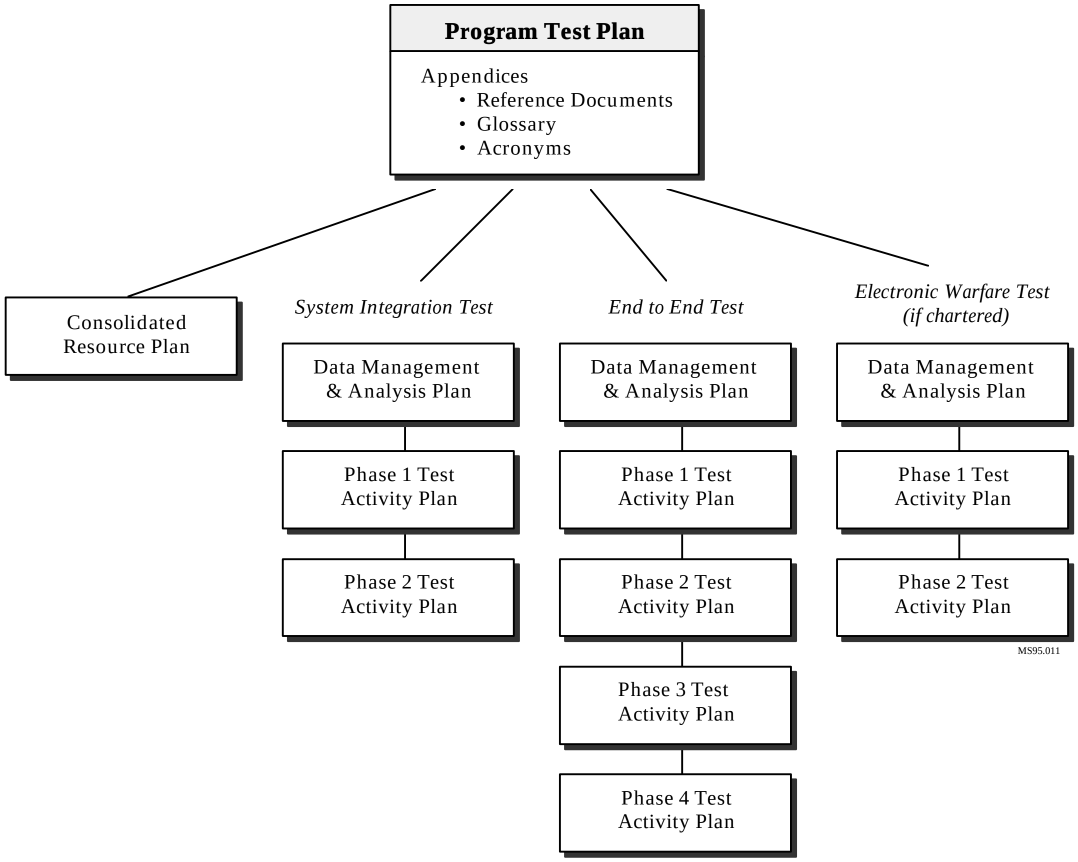
PREFACE

Joint Advanced Distributed Simulation (JADS) Joint Test and Evaluation (JT&E) is chartered to determine the utility of advanced distributed simulation (ADS) as a methodology for both Developmental and Operational Test and Evaluation (DT&E and OT&E). To accomplish this, JADS is conducting multiple tests, each with multiple phases. These focused evaluations of ADS utility will be augmented by leveraging with other ADS activities throughout DoD. The Program Test Design (PTD, Feb. 95) contains baseline information on the conduct of the two tests JADS was chartered to conduct: the System Integration Test and End-To-End Test. An Electronic Warfare Test may be approved at a later date.

This PTP provides a much higher level of detail than was possible in the PTD. However, the nature of the multi-test, multi-phase JADS test approach defies developing a single document with all required details. Therefore, the JADS team elected to produce a PTP that contains all program-level information plus adequate test-specific information to allow the reader to grasp how JADS plans to satisfy its charter. Test Activity Plans (TAPs) will be published separately, one for each phase of the two JADS tests (and the Electronic Warfare Test, if chartered). They will each be published with adequate lead time before commencing test execution for that particular phase. A pictorial of how the documents deaggregate from the PTP is shown below.



JADS JT&E is sponsored by the Under Secretary of Defense (Acquisition and Technology), Director Test, Systems Engineering and Evaluation [USD(A&T)DTSE&E]. The program monitor within USD(A&T)DDTSE&E/A&SP is Ms. Loretta Bloomer. The Air Force is designated as the lead Service, with participation by both the Army and Navy.

The following lists those individuals involved in writing or preparing the PTP: Colonel Mark Smith, Joint Test Director; Mr. Eric Keck, JADS Technical Advisor; Lt. Colonel Dave Jewell, System Integration Test Team Lead; Major Dick Elder, Analysis Team Lead; Ms. Ann Krause, Legacy Manager; Mr. John Reeves, SAIC; Mr. Gary Marchand, SAIC; Dr. Larry McKee, SAIC; Mr. Joseph Faix, SAIC; Mr. Dean Gonzalez, SAIC; Mr. Clyde Harris, SAIC; Ms. Rebecca Nolda, SAIC; Mr. Bob Lewis, Quality Research; and Mr. David Brown, Editor, SAIC.

EXECUTIVE SUMMARY

BACKGROUND

The JADS JT&E was chartered on 17 October 1994. The Air Force was designated as the lead Service; the Army and Navy were designated as participating Services.

JADS is chartered to investigate the utility of ADS as a methodology for both developmental test and evaluation (DT&E) and operational test and evaluation (OT&E). JADS is to determine the utility of ADS at its current level of maturity, identify the methodologies associated with using ADS, and identify growth requirements so that ADS will better meet the needs of the T&E community.

TEST PROGRAM OVERVIEW

In order to provide the T&E community with tangible proof as to the utility of ADS as a methodology, JADS is performing two tests—the System Integration Test (SIT) and the End-To-End Test (ETE). These two tests address major classes of systems, precision guided munitions (PGM) and Command, Control, Communications, Computer, and Intelligence (C^4I) respectively, as well as numerous T&E applications, both developmental and operational. Additionally, a third test, evaluating ADS utility to electronic warfare T&E, may be chartered at a later date.

To maximize the breadth of our findings on ADS utility to T&E, JADS is leveraging off several other activities utilizing ADS. These include training exercises, advanced technology demonstrations and other T&E efforts. Data and results will be gleaned from these activities and included in the broader JADS report. A pictorial of the JADS test concept is at Figure ES-1.

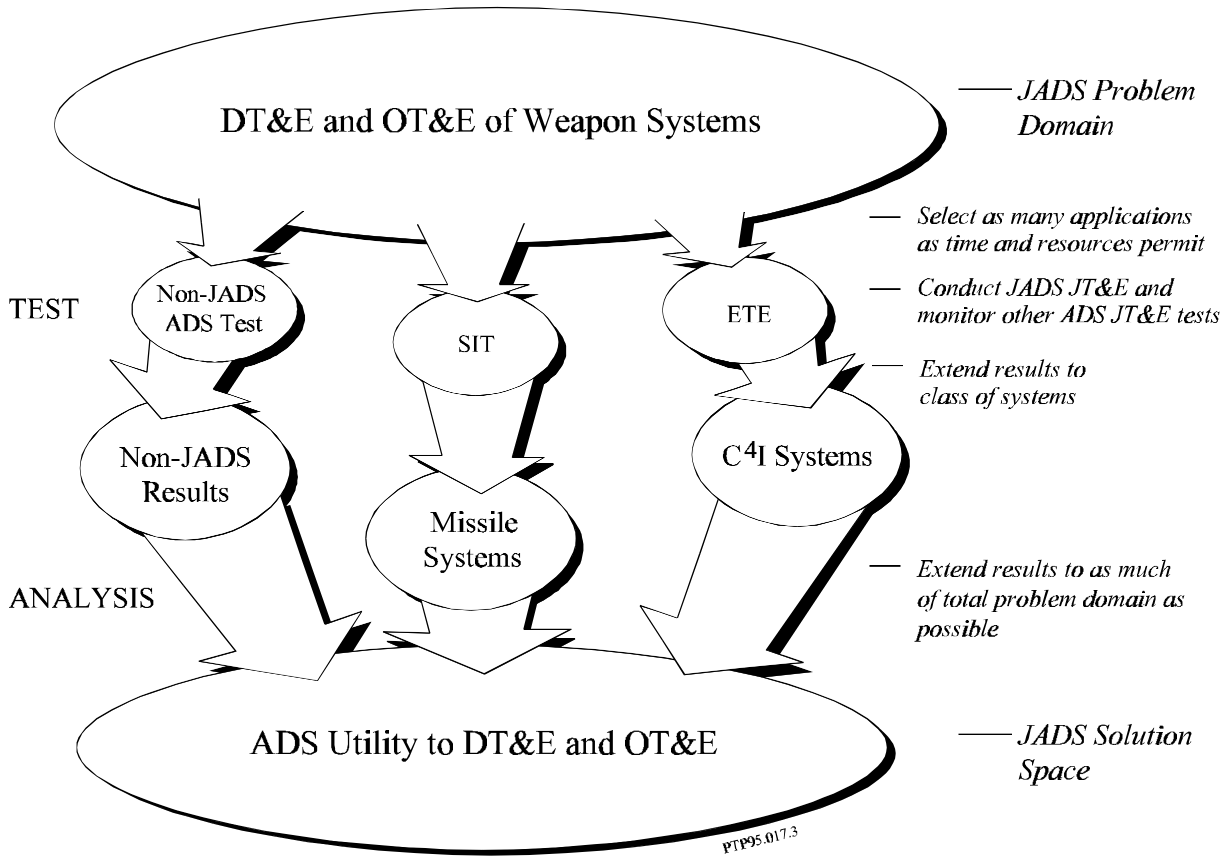


Figure ES-1. Test Concept

System Integration Test

The SIT will evaluate the utility of ADS in complementing T&E of PGMs. The AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) was chosen as a representative PGM in which to introduce ADS as a methodology. Both DT&E and OT&E aspects are being explored. DT&E applications are being explored by using a hardware-in-the-loop facility to simulate the missile. This allows detailed performance of missile subsystems to be monitored, typical of DT&E. The OT&E characteristics of the SIT result from the use of actual aircraft performing operationally realistic engagements. Of particular value is that the launch aircraft fire control radar operates in the real environment and is affected by weather, electronic counter measures, clutter, and other variables for which good digital models do not exist. This means that the T&E is more representative of the performance of the integrated weapon system. SIT is a two-phased test; Phase 1 activities are at Eglin AFB, and Phase 2 activities are at Eglin AFB, NAS Pt. Mugu and NAS China Lake. A pictorial of the SIT is at Figure ES-2.

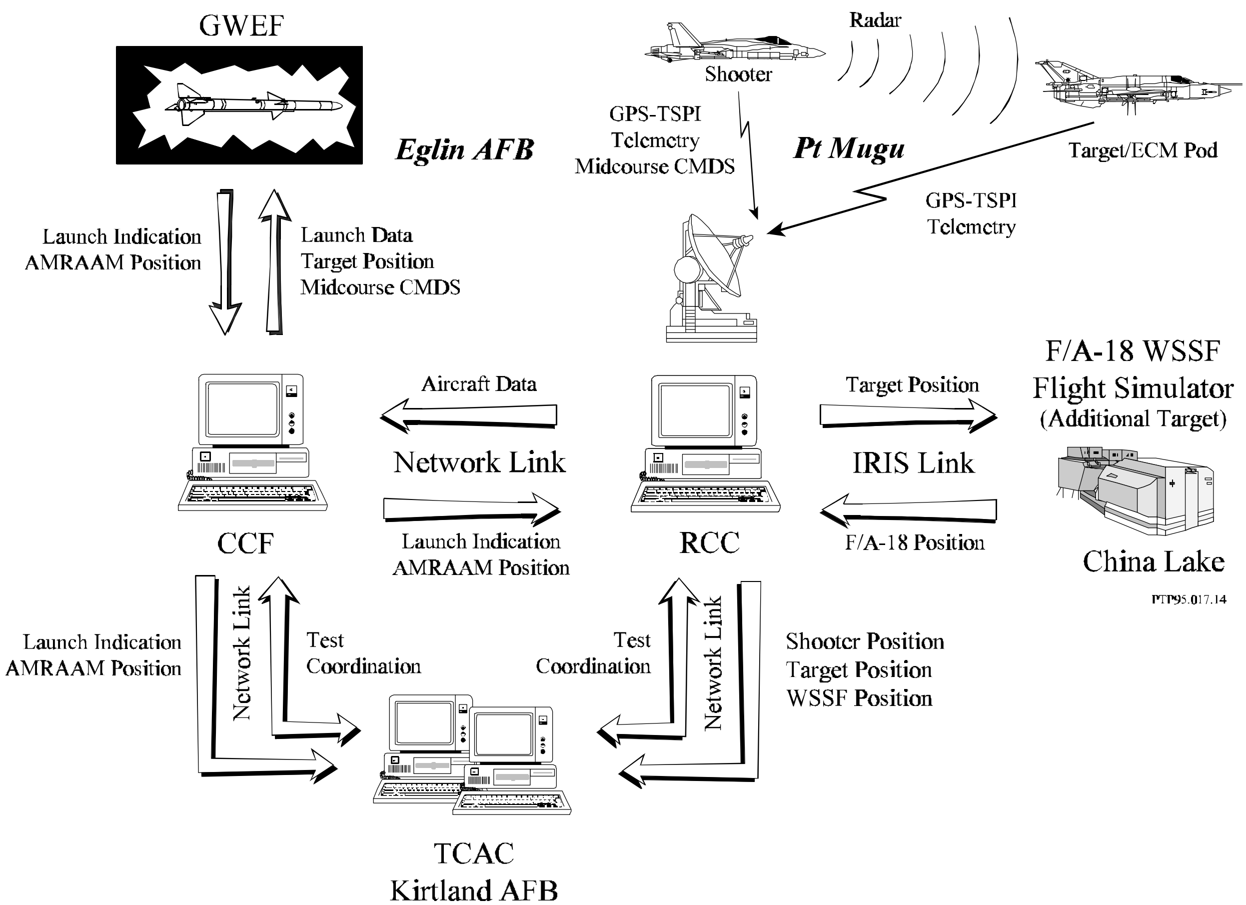


Figure ES-2. System Integration Test Configuration

End-To-End Test

The ETE will evaluate the utility of ADS to complement the DT&E and OT&E of a C^{4}I system. ADS will be used to provide a more robust test environment that provides more representative numbers of threats plus the complementary suite of other C^{4}I and weapon systems with which the system under test would interact. The Joint STARS suite of E-8C aircraft and Ground Station Module was chosen as a representative C^{4}I system on which to introduce ADS as a methodology in both DT&E and OT&E settings. The ETE is a four-phase test. The first two phases occur in a laboratory environment, suited for exploring DT&E and early OT&E applications. Phase 3 checks compatibility of the ADS environment with the actual Joint STARS equipment, and Phase 4 is live open-air tests replicating missions performed during the Joint STARS Multi-Service Operational Test and Evaluation. A pictorial of the ETE is at Figure ES-3.

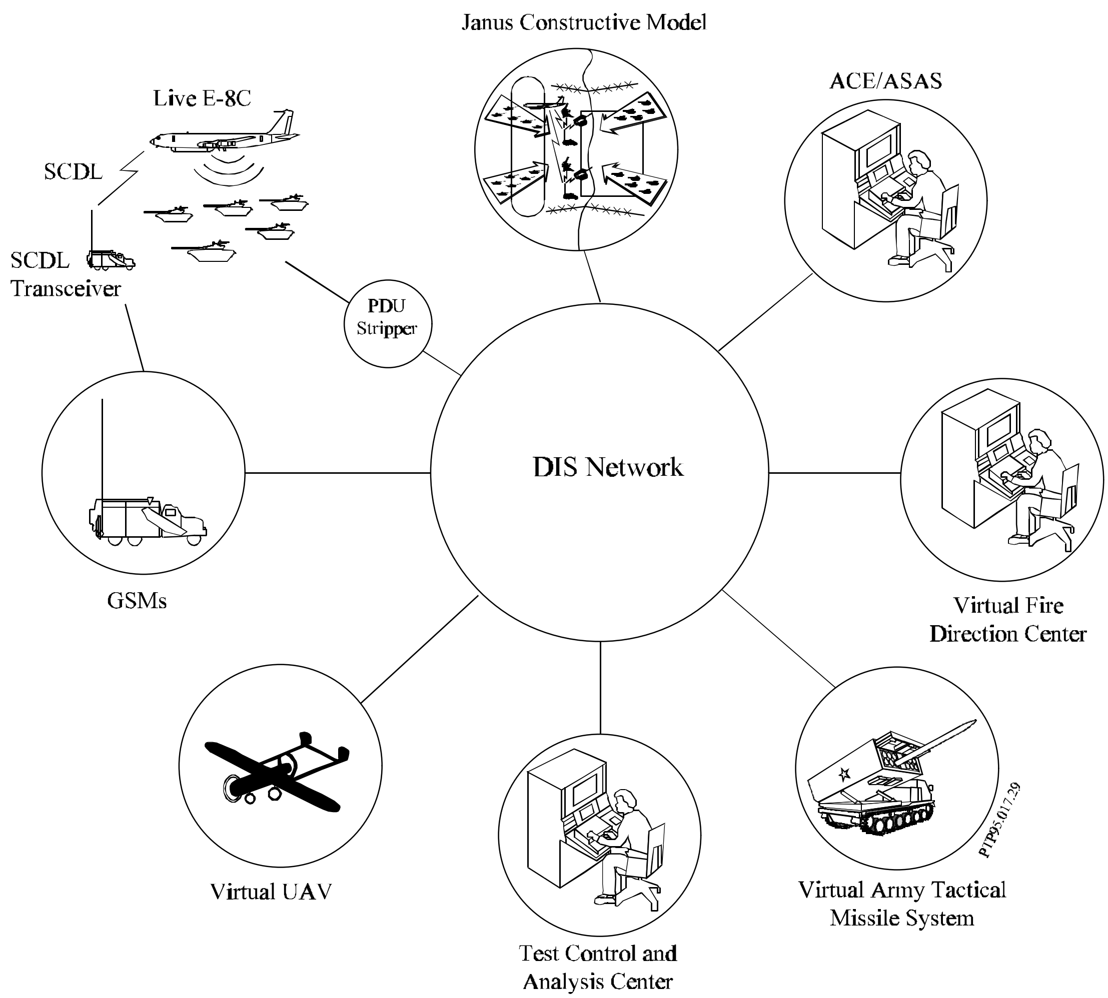


Figure ES-3. End-To-End Test Configuration

Schedule

The program schedule for the major activities within each test program (SIT and ETE) and the significant program milestones is shown in Figure ES-4. As illustrated, multiple tasks for each of the test programs must be accomplished in parallel to assure the JT&E is completed within the allocated timeframe. The program schedule will be adjusted when the Electronic Warfare test is chartered.

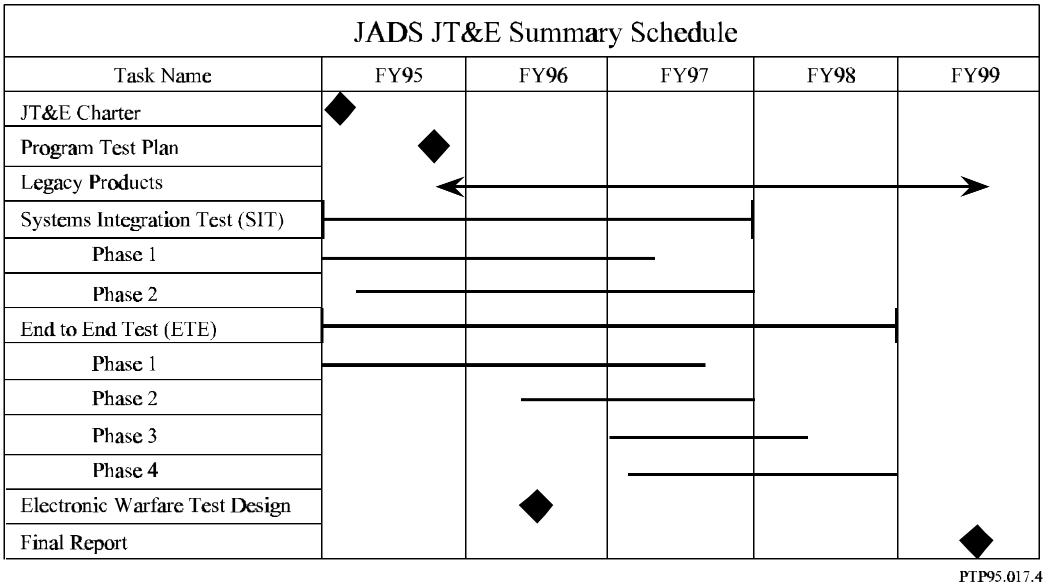


Figure ES-4. Summary Program Schedule

VERIFICATION, VALIDATION AND ACCREDITATION

Verification, Validation, and Accreditation (VV&A) is an extremely important topic in modeling and simulation. The test and evaluation community has much experience performing VV&A of individual models, but not addressing complications raised by linking those models for a test event. The training community has developed procedures for linking models but fidelity requirements for training and test and evaluation are very different. JADS will establish a general plan for the verification, validation, and accreditation of ADS components for use in T&E. This plan will build on past work in VV&A and incorporate the best from both the training and T&E worlds. The general plan will then be used to plan VV&A for each JADS test program. These plans will build on the past VV&A work for all the models used in the JADS tests and concentrate on the federation of models and their interactions. This work will be used as a model for the JADS VV&A legacy.

ANALYSIS APPROACH

The utility of ADS for T&E is founded upon its ability to provide valid data during test execution. The first step of the analysis is to determine whether or not (or perhaps, to what degree) ADS provides valid data during test execution. This is captured in the first objective of the first issue. The second step of the analysis, addressed in the second objective of Issue 1, addresses the benefits of applying ADS to the various aspects of T&E. The second issue addresses anticipated limitations in the application of ADS to T&E, and the third issue addresses what requirements must be introduced in order to support a more complete T&E capability in the future. The table below lists the JADS Issues and Objectives.

Table ES-1. JADS Issues and Objectives

Issues	Objectives
Issue 1: What is the present utility of ADS, including DIS, for T&E?	Objective 1-1: Assess the validity of data from tests using ADS, including DIS, during test execution. Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E.
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?	Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E. Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E. Objective 2-3: Develop and assess methodologies associated with ADS for T&E.
Issue 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?	Objective 3-1: Identify requirements for ADS systems that would provide a more complete T&E capability in the future.

JADS will obtain data for an evaluation of the present utility of ADS from three different sources. The JADS tests will provide the primary source of data. Other T&E-related ADS activities will provide a second source of data. The Test Control and Analysis Center (TCAC), defined and implemented for JADS test control and analysis, will provide the third source of data for the evaluation. The evaluation approach, using these data, is described in what follows.

The JADS tests will "repeat" portions of previously-conducted tests for specific systems (baseline tests). The primary evaluation method for these tests will be to compare quantitative data from the JADS tests to the baseline tests for validity. Also, the JADS tests will use ADS in an effort to identify risk areas earlier, improve realism, reduce costs, etc., and will provide insights regarding ADS's utility to T&E.

The JTF will monitor and collect pertinent data from selected, T&E-related, other ADS activities. Data from these activities will not, in general, be used to address the data validity questions, since baseline test "truth" data will not be available. However, data will provide insights into the utility of ADS for the early phases of acquisition, as well as for constraints and concerns and methodologies when using ADS.

The TCAC will provide insights regarding distributed test control and analysis concerns. Network performance data will also be collected from the TCAC (and from the planning and setup of the required ADS networks). These data will be used to gain insights into ADS-specific network constraints and concerns.

DATA MANAGEMENT

The goal of JADS data management is to provide the requisite data to support the JT&E analysis efforts while using existing data collection and reduction capabilities to the maximum extent possible. The data generated during the numerous test activities represent a major investment of time, funds, and personnel. The data management function will be structured to provide effective and efficient data collection, control, and processing. A JADS data management plan will be developed that will map individual data elements up to the JADS Issues. Individual data management plans will be developed for each of the JADS test events.

LEGACY

A key concern of the JADS JTF is how the insights gained by the JADS JTF will be transitioned to the T&E community. A transition plan will be developed to identify the T&E customers (e.g., OSD, program managers, developmental testers, operational testers, test ranges, test facilities, etc.) that could benefit from the JADS JTF legacy and the approach to be taken for each. The products supplied will serve two purposes: first, to inform the T&E community on the benefits and potential pitfalls of using ADS in T&E, and second, to educate these T&E organizations on how to incorporate ADS in T&E planning. Additionally, the JADS JTF will facilitate the use of ADS in T&E by recommending changes to infrastructure and developing methodologies for how to plan, VV&A, execute, and analyze an ADS supported test. As information is developed and available the JADS team will transition that information to the T&E community through newsletters, briefings, and interim reports.

1. INTRODUCTION

The purpose of the Program Test Plan (PTP) is to expand and update test concepts, approaches, and methodologies developed in the Program Test Design (PTD). This PTP describes and integrates the details of the two approved test programs, the System Integration Test and the End-To-End Test, their multi-phased test activities, and specific analysis methodologies to address JADS JT&E issues. A third test program, an Electronic Warfare Test, will be incorporated into this PTP after it is chartered. A Test Activity Plan (TAP) will be developed for each phase of testing within the System Integration and End-To-End Tests. The TAPs will be published separately and they will detail the procedures for the preparation, conduct, and execution of each test activity in consonance with the PTP.

1.1 BACKGROUND

Since the mid-1980s, rapidly evolving information systems technology has been put to work in support of Department of Defense (DoD) needs. Early efforts were conducted jointly by the Defense Advanced Research Projects Agency (DARPA, now renamed ARPA), and the US Army. This early project was named Simulation Network (SIMNET), and it was sharply focused on training applications. Conceptually, the project was directed toward linking training devices (simulators), with human operators in the loop, at distributed geographical sites, in a common virtual environment. The people involved could interact with each other through the common environment, in near-real-time. SIMNET has evolved into Distributed Interactive Simulation (DIS), a technology implementation which is more flexible and far reaching. The term “DIS”, in the most common usage, refers to the implementation managed by the US Army Simulation, Training, and Instrumentation Command (STRICOM). A formal Institute of Electrical and Electronics Engineers Standard (IEEE 1278) has been established for DIS.

Advanced Distributed Simulation (ADS) is the technology and procedures that provide a time and space coherent, interactive synthetic environment through geographically distributed and potentially dissimilar situations. Any combination of live, virtual, or constructive simulation of people and/or equipment can be used. ADS is the concept, DIS is one application of ADS. ADS includes DIS, but is not restricted to DIS.

Because of widespread interest in using ADS technology to support test and evaluation (T&E), the Air Force Operational Test and Evaluation Center (AFOTEC) proposed that a Joint Test and Evaluation (JT&E) program would serve well as an exploratory vehicle. Accordingly, the JADS JT&E program was nominated, and approved for feasibility study in 1993. The nomination was motivated by the T&E community's concern about long-standing test constraints and limitations, and the potential utility of the ADS technology for relieving or easing some of those constraints and limitations. Interest was shared by developmental test and evaluation (DT&E) and operational test and evaluation (OT&E) communities. The Services concurred in the need for a rigorous examination of ADS application to testing, and the Office of the Secretary of Defense (OSD), Director of Test and Evaluation, chartered JADS as a full joint test program.

1.2 CHARTER

The JADS JT&E was chartered on 17 October 1994. The Air Force was designated as the lead Service; the Army and Navy were designated as participating Services. The Air Force, as the lead Service, provides an O-6 Joint Test Director (JTD). Each of the participating Services provides a Deputy Test Director (DTD). The JTD reports to the OSD Deputy Director for Air and Space Systems.

JADS is chartered to ". . . investigate the utility of Advanced Distributed Simulation (ADS) for both developmental test and evaluation (DT&E) and operational test and evaluation (OT&E). JADS will investigate the present utility of ADS, including Distributed Interactive Simulation (DIS), for T&E; identify the critical constraints, concerns, and methodologies when using ADS for T&E; and finally, identify the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future." A copy of the JADS charter is included in Appendix A.

1.3 PTP OVERVIEW

This PTP is organized into eight sections and appendices A through I. The PTP is designed to give the reader a comprehensive overview of the program, an understanding of program and test concepts, and some insights into top level test activities. Detailed test procedures are incorporated into the Test Activity Plans (TAP) and are not included in the PTP. Program level issues are discussed in Section 2. Individual test programs are discussed in Section 3. Section 4 describes the VV&A process. Analysis and Data Management are described in Sections 5 and 6 respectively. Section 7 describes the legacy products the JTF expects to produce. The final section, Section 8, details JTF management and organization. Documents that have been used as references and guidelines for the development of the JADS JT&E and the PTP are listed in Appendix B. Appendix C provides a glossary of terms used in this PTP and Appendix D lists and defines all acronyms used. The remaining appendices will be published separately.

2. TEST PROGRAM OVERVIEW

This section provides an overview of the JADS JT&E.

2.1 SCOPE AND ISSUES

2.1.1 Scope

The JADS charter directs an evaluation of the present utility of ADS for both DT&E and OT&E of military systems. The terms "present" and "military" provide limits to the scope of the evaluation. However, even within these limits, the scope is still broad. It includes early DT&E as well as Follow-On OT&E. It includes space systems, subsurface systems, C4I systems, fighter systems, etc. Time and resource constraints allowed testing of only two systems. In order to provide a more comprehensive evaluation of ADS, JADS will monitor and collect data for the evaluation from other ADS T&E-related activities (see Figure 2-1). However, there may be classes of systems not addressed by JADS.

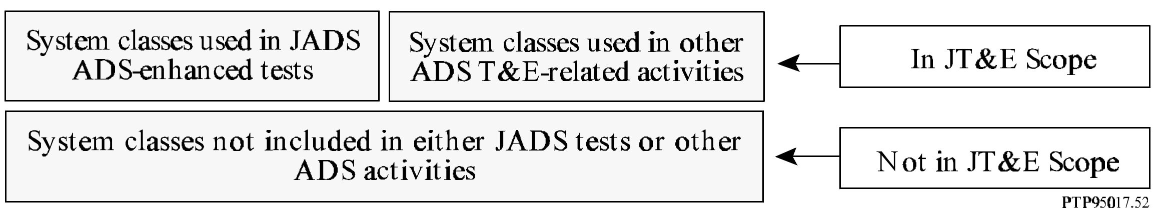


Figure 2-1. JADS ADS Evaluation Scope

2.1.2 Issues And Objectives

Questions in the form of issues were developed to structure the JADS evaluation. The three JADS JT&E issues were derived from the charter. The first is focused on assessing the utility of ADS for T&E. The second focuses on constraints, concerns, and methodologies when using ADS for T&E. And, the third focuses on requirements for future ADS development to improve its T&E utility.

The questions raised by the T&E community concerning using ADS technology to support T&E include: "Will it work with the rigor necessary to support testing?"; "Are the data gathered using ADS valid and/or credible?"; "Is the technology mature enough for a T&E tool?"; and "How affordable is using this technology for testing?" The JTF is structured to answer these questions.

The JADS issues and objectives are introduced in this section, and more detail is provided in Sections 3 and 5. Section 3 describes how individual tests will provide data to support the JADS issues and objectives.

Table 2-1 summarizes the program-level Issues and Objectives that are described in the subsequent paragraphs.

Table 0-1. JADS Issues and Objectives - Summary

Issues	Objectives
Issue 1: What is the present utility of ADS, including DIS, for T&E?	Objective 1-1: Assess the validity of data from tests using ADS, including DIS, during test execution. Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E.
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?	Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E. Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E. Objective 2-3: Develop and assess methodologies associated with ADS for T&E.
Issue 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?	Objective 3-1: Identify requirements for ADS systems that would provide a more complete T&E capability in the future.

ISSUE 1: What is the present utility of ADS, including DIS, for T&E?

Some questions from the testing community concerning the use of ADS to support T&E are: “What does it cost? Does it work? Will it support T&E earlier in the acquisition process?” To be useful for T&E, ADS must either provide operational realism equivalent to live testing at reduced cost, or it must provide increased operational realism at an affordable cost. Both cost benefits and the value added of using ADS are important measures to determine the utility of ADS to support T&E. The objectives that will be used to address this issue are:

- Objective 1-1: Assess the validity of data from tests using ADS, including DIS, during test execution.

The key to the utility of ADS for T&E lies in its ability to provide valid data when it is used in test execution. If ADS does not provide valid data when used during test execution, then it has no utility. If it does provide valid data, then it may have a great deal of utility.

- Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E.

Once the validity of ADS data in test execution is established, the benefits of using ADS in T&E can be addressed. The benefits of ADS for all phases of T&E as well as for the early phases of the acquisition process will be addressed in the subobjectives and measures for this objective.

ISSUE 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?

The issue looks at characteristics such as fidelity and maturity of the technology as required for T&E. The execution of the test will determine if the necessary maturity does exist as well as identify the strengths and weaknesses in the maturity of the technologies for other T&E use. The objectives that will be used to address this issue are listed below.

- Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E.

In the design of a specific ADS T&E methodology to support a test, assembling a network of constructive, virtual, and live simulations presents a host of new technical and management issues for testers. These issues may include such problems as simulation identification and capability evaluation, integration of models, interface development and testing, network development, network operations and scheduling management, and verification and validation of entire networks. In addition, factors such as seamlessness, fidelity, latency, etc. need to be considered based on the desired output or function of the ADS T&E methodology. These design issues as well as the performance shortfalls of the resulting implementation will be addressed in this objective.

This objective also looks at the reliability of the ADS network assembled for each test program. While each individual component in an ADS network has its own reliability, the linked ADS network of simulations and live systems used in a test may have a totally different reliability. This is an important maturity issue to answer during the JT&E. Can the ADS network infrastructure be reliably scheduled? Will the network run when initiated? Will it operate continuously for an adequate amount of time to complete the test event? The ADS T&E methodology infrastructure must possess some adequate level of operational reliability to be useful to support the T&E.

- Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E.

This objective deals with the maturity of the overall ADS support infrastructure. The impact that the distributed nature of ADS testing, as well as the increased use of simulation, has upon existing configuration management systems and data management and analysis support systems will be addressed.

- Objective 2-3: Develop and assess methodologies associated with ADS for T&E.

The JTF will modify existing procedures as necessary or develop additional procedures for planning, designing, testing, and operating the ADS T&E methodologies used in the JT&E. The JTF will also identify and report the strengths and weaknesses of the various management, network, and simulation issues related to assembling an ADS infrastructure.

ISSUE 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?

The test community has not yet developed its requirements for specialized support in the form of network and simulation standards to support T&E. ADS is still evolving and issues remain in such areas as fidelity, data structures, security, scaleability, emission representations, and reactive terrain. The objective that will be used to address this issue is:

- Objective 3-1: Identify requirements for the ADS systems that would provide a more complete T&E capability in the future.

For any given application of ADS in a specific test program, there are technological alternatives for implementation. For example, only one of several networks (e.g., DSI or leased commercial) may be employed during a given test, but networks may not be equally capable of supporting that test. In the development of the test concepts for this JT&E, alternatives were considered and some were rejected as not appearing mature enough to support the test during its life span. Also, to scope this JT&E at a reasonable level, choices were made concerning which systems and which test issues would be selected for evaluation in this test. For these reasons, the maturity of the technology as a whole cannot be tested in this one JT&E. However, valuable information on the maturity or lack of maturity of ADS to support T&E in general will be gathered and should be an output of this test. For this objective, the JTF will include in the final report a description of the ADS maturity shortfalls that it discovered while planning and executing this test that can be used as requirements to influence future development of the technology to support T&E. There are no measures associated with this objective, and no ratings are required.

2.2 TEST CONCEPT

The JADS problem domain includes the DT and OT of all types of weapon systems. Obviously, the JADS JT&E could not conduct a DT and OT test for every kind of weapon system possible. Therefore, the JADS JT&E will select as many applications as time and resources permit. The JADS program test concept is shown in Figure 2-2.

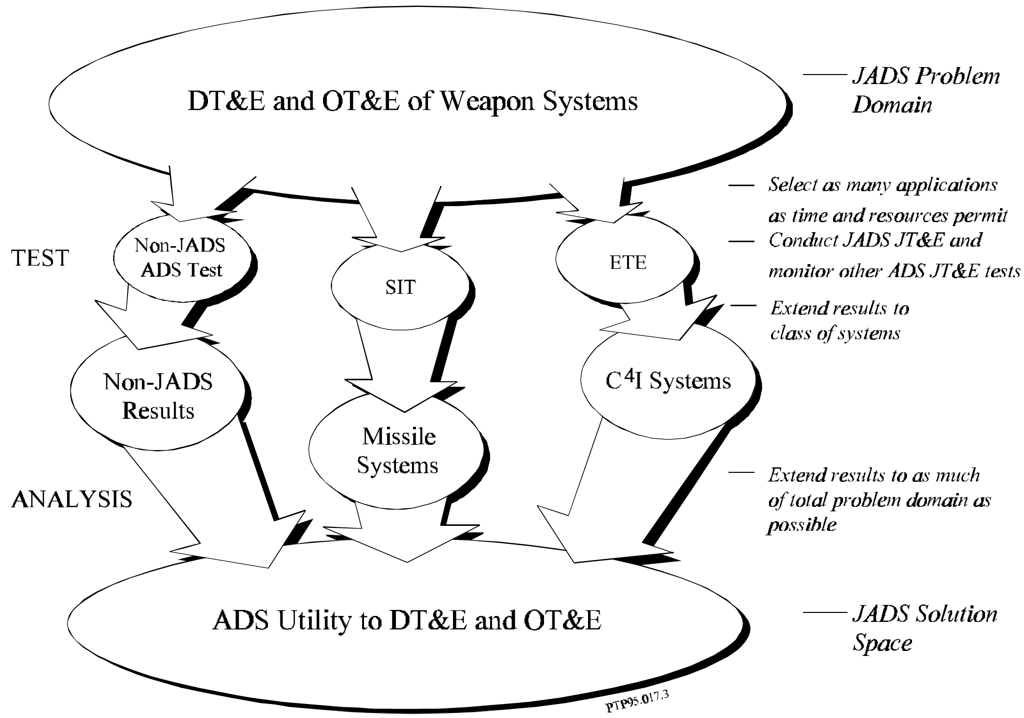


Figure 2-2. JADS Test Concept

2.2.1 Selected Test Programs

As currently approved, the JADS JT&E program includes two tests, a System Integration Test (SIT) and an End-to-End Test (ETE). The SIT is a two-phased test which examines the use of ADS technology to support precision guided munition testing. The ETE Test is a four-phased test which examines the use of ADS technology to support C^4I system testing. A third test program based on an Electronic Warfare program is being planned, but it is currently not chartered. Each test is divided into phases that are identified in this plan as Test Activities. An overview of each test activity is presented in Section 3.

The JT&E is based on cooperating with specific ongoing test activities whose results can be compared with the JTF results using ADS-augmented tests of the same or similar systems. These baseline comparisons will be used to establish the validity of ADS testing for each of the test programs. Once this baselining is accomplished, ADS will be used to address shortfalls in conventional testing. An assessment of the utility of this new or enhanced capability provided by ADS will be made.

There are many non-JADS ADS tests or demonstrations being conducted. The JADS JTF will make a survey of these tests and determine which ones complement the two JADS test programs. The results from these non-JADS ADS-enhanced tests will be used to supplement the JADS specific results.

Table 2-2 is the JADS test matrix showing where data for all JADS' issues and objectives will be collected.

Table 2-2. JADS Test Matrix

	SIT	ETE	TCAC	Other
Issue 1: What is the present utility of ADS, including DIS, for test and evaluation?	X	X	X	X
Objective 1-1: Assess the validity of data from tests using ADS, including DIS, during test execution.	X	X	X	X
Objective 1-2: Assess the benefits of using ADS, including DIS, in test and evaluation.	X	X	X	X
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?	X	X	X	X
Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E.	X	X	X	X
Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E.	X	X	X	X
Objective 2-3: Develop and assess methodologies associated with ADS for T&E.	X	X	X	X
Issue 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?	X	X	X	X
Objective 3-1: Identify requirements for ADS systems that would provide a more complete T&E capability in the future.	X	X	X	X

2.2.2 Extending Test Program Results

Once the results from specific systems are obtained and analyzed, the JADS JTF will extend or extrapolate these results to classes of systems. Classes of systems are defined by example as Air-to-Air Missiles, Aircraft, C4I Systems, Electronic Warfare Systems, Submarines, Spacecraft, etc. Each of these classes of systems present unique challenges to the T&E community responsible for their evaluation.

The final step will be to take the results for those classes of systems for which ADS test data was available and to extend them to as much of the total JADS problem domain as possible.

2.3 SCHEDULE

The program schedule for the major activities within each test program (SIT and ETE) and the significant program milestones is shown in Figure 2-3. As illustrated, multiple tasks for each of the test programs must be accomplished in parallel to assure the JT&E is completed within the allocated timeframe. The program schedule will be adjusted when the EW test is chartered.

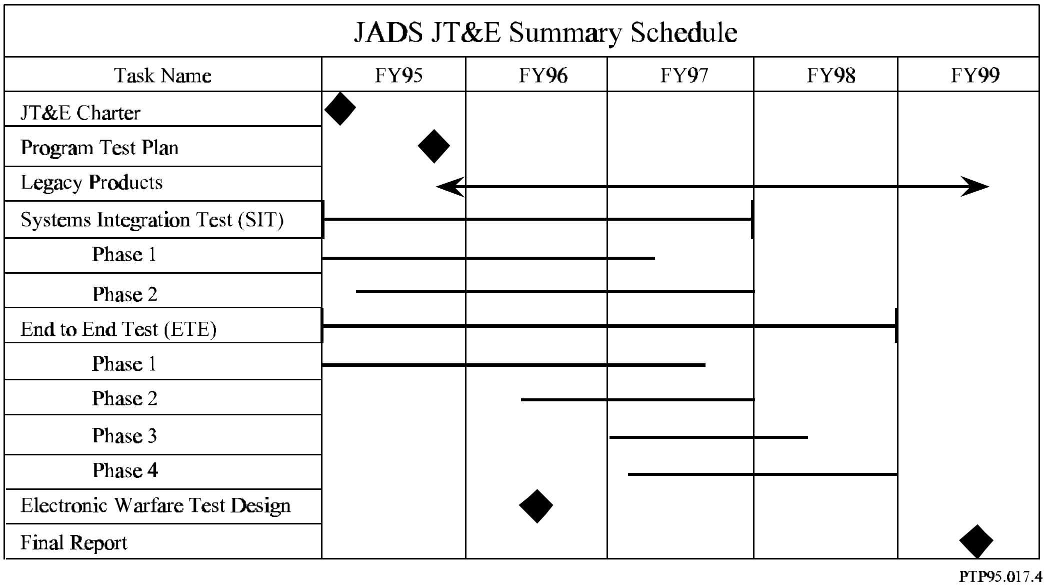


Figure 2-3. JADS Program Schedule

3. TEST AND EVALUATION APPROACH

This section describes the JADS test and evaluation approach in more detail. First, a general description of the JADS test and evaluation approach is provided. This description is followed by more detailed descriptions of the JADS JT&E test programs and of the other ADS activities that will be used to address the JT&E issues. Finally, a description will be provided of the Test Control and Analysis Center (TCAC) and its role in the evaluation.

The JADS JT&E is not focused on evaluating the SUT. The JT&E is focused on the benefits, costs, and performance of the ADS-augmented system testing.

3.1 GENERAL TEST AND EVALUATION APPROACH

As presented in Section 2, JADS will obtain data for an evaluation of the present utility of ADS using two different methods. The first T&E method uses testing to provide data for the evaluation. The second T&E method uses data from other T&E-related ADS activities as a means of expanding the evaluation to other classes of systems and other phases of the acquisition process. The general test and evaluation approach for each of these T&E methods is described in what follows.

In the first T&E method, JADS will conduct tests to evaluate the utility of ADS. The JADS tests will "repeat" portions of previously-conducted tests for specific systems (baseline tests). The JADS tests will use ADS in an effort to assess the utility of ADS for T&E, i.e. reduce costs, improve realism, etc. Quantitative data from the JADS tests will be compared to the baseline tests for validity.

In the second T&E method, the JTF will monitor and collect pertinent data from T&E-related, other ADS activities. Data from these activities will not, in general, be used to address the data validity questions, since baseline test "truth" data will not be available. However, data will provide insights into the utility of ADS for the early phases of acquisition, as well as for constraints and concerns and methodologies when using ADS.

ADS-enhanced tests will, in general, employ assets concurrently at geographically-dispersed sites. A central controlling node to support control and quick-look analysis for test planning, test rehearsal, test execution, and post-test evaluation will be a requirement. Therefore, the JTF will define and implement a Test Control and Analysis Center (TCAC) to satisfy this requirement for its tests. The TCAC will provide data regarding distributed test control and analysis concerns for the JTF evaluation.

3.2 ADS

In the context of the JADS JT&E, ADS is any application or architecture which employs the characteristics of distribution and networking in a way that permits a number of nodes, entities, or devices (at least two) to interact with each other for some common or shared purpose related to T&E.

3.2.1 Description

This section describes what ADS is and how it is employed by the JTF with a central controlling node known as the Test Control and Analysis Center (TCAC).

3.2.1.1 Components

As in any complex system, an ADS is made up of components. The components can be assembled in different configurations, can be connected through different media, and can communicate in different ways. In a given ADS application, the components are assembled to address a specific set of issues or objectives.

a) *Player Components.* There are three possible types of players listed below. (In this document, the term "players" is used synonymously with the DIS terms "participants" and "entities.")

- Live: real systems, real people, and real environments;

- Virtual: simulators;

- Constructive: models, digital simulations, computer generated forces, systems and environments.

b) *Networking Components*. Information systems technology is the enabling technology of ADS. Networking is a subset of that technology. Networking is a characteristic of all ADS architectures, and it includes the transmission media, interface, translation, encryption, and a variety of other processing devices. A given architecture might incorporate a local area network (LAN), a wide area network (WAN), or both. Distribution requires linking, and linking is accomplished via a network. The dependent relationship between distribution and the supporting networks places a significant emphasis on a performance and analysis capability which provides near real-time information on network performance. Network performance may be a critical element of test performance.

c) *Supporting Components*. Supporting components include data structures, data bases, interfaces to live, virtual, and constructive players, and facilities for test control and analysis.

The DIS Protocol Data Units (PDUs) are widely used and accepted data structures which work well in a variety of ADS applications. However for many test applications, the DIS

PDUs will have to be either modified or replaced with existing test range or test facility data exchange standards. An analysis will be made for every simulation interface in the JADS JT&E to determine if the use of DIS PDUs is practical or not.

For all the entities in a federated simulation to be on a common "playing field", common data bases must be established and distributed to all the simulation sites. Unnatural entity behavior or an unfair fight will result if common data bases are not established.

Interfaces convert the messages sent across the network into something the live, virtual, or constructive entity can understand. The interface must properly stimulate various types of sensors and communication equipment which are on-board the simulated entity as well as stimulate the human operator.

3.2.1.2 Procedures

To support ADS testing, procedures must be established for designing an ADS test, for Verification, Validation, and Accreditation (VV&A) of the test, for execution of the test and for analysis of the test. These procedures are well established for conventional methods of testing, but are either being developed or not available for ADS testing.

a) *Design*. ADS potentially provides the test designer a great deal more flexibility than conventional test methods. One can now select either a live, virtual, or constructive representation of each simulated entity in the test scenario. The designer can now trade off fidelity versus costs as needed to meet specific test requirements. Procedures and automated design tools are needed to support these design trade-offs.

b) *VV&A*. The VV&A process is as integral to the use of ADS as it is to any other application involving the use of simulation. VV&A of an ADS architecture must go beyond the traditional VV&A of the participating entities, to the VV&A of the shared, interactive environment. The VV&A procedures developed for simulations must be extended to this new environment.

c) *Execution*. The most challenging of the procedures for test execution will be those associated with test control. Coordinating and synchronizing heterogeneous simulations at distributed locations, while insuring data integrity, will be a significant challenge. Procedures must be developed which enable this coordination to happen on a routine basis before ADS can be a viable test method.

d) *Analysis*. Lastly, procedures for post-test analysis are required which support rapid test reconstruction and extrapolation of test results to other test scenarios.

3.2.2 Test Control and Analysis Center

Every T&E activity which employs assets concurrently at distributed sites needs a central controlling node. The JTF's TCAC is such a node, and it supports control and quick-look analysis for test planning, test rehearsal, test execution, and post-test evaluation.

Effective test control is an essential ingredient of ADS support for all types of T&E. The JTF will assess the benefits and problems associated with controlling remote test sites. The JT&E has a requirement (within common sense fiscal constraints) to develop, implement, and assess a test control and analysis mechanism. The TCAC implementation will provide actual control in some instances and a proof-of-principle in others.

3.2.2.1 General Requirements

Central control is a prerequisite for T&E because the activity at distributed sites must be coordinated and synchronized. Use of range and instrumentation facilities, test articles, and specialized laboratories is very expensive. Any test force/team must have a system with the capabilities to maximize the production of valid test events, and minimize the loss of dollars, manpower, range time, and other assets to unsuccessful test attempts. A functional TCAC must be capable of controlling participant activity, monitoring the status of network performance, instrumentation, communication, and data collection systems, and conducting quick-look analysis. This quick-look analysis capability supports rapid rescheduling of test sequences and events "on-the-fly."

3.2.2.2 Functional Requirements

In simplest terms, the TCAC must support test planning, test rehearsal, training, test execution and control, quick-look analysis, and post-test evaluation and analysis. To support test planning, rehearsal, and test training activity, the TCAC must be able to configure itself as necessary to support those functions. During test execution, the TCAC must be able to communicate with all test participants, issue direction as appropriate, and record all relevant data sources. In the post-test phase, the TCAC must be capable of supporting test evaluation and analysis.

a) *Test Planning Support*. The TCAC will function as the controlling node for internal and external JADS actions designed to validate test concepts, check out test procedures, and train test participants. The training during the planning support phase is generally limited to local test participants. Initial concept validation will usually involve JADS hardware and software operated by JADS personnel, although interaction with other sites is not ruled out.

b) *Trial Rehearsal*. While trial rehearsal is unquestionably a subset of test planning, in an ADS context, rehearsal differs significantly from earlier planning support. A JADS trial rehearsal will generally involve the major nodes and network links associated with an actual test.

Simulators will serve as surrogates for some live test articles, but otherwise, the rehearsal will look very much like the real test. Humans will be in the loop to the degree feasible. Rehearsals will serve to refine procedures and provide additional training to the test participants. In particular, rehearsals offer a necessary opportunity to enhance the training of those participants located at the remote sites.

c) *Test Execution*. During ongoing testing, the test director will issue direction to the test participants from the TCAC. The test director is responsible for synchronizing, initiating, terminating, and rapidly rescheduling test activity using TCAC assets.

d) *Test Analysis and Evaluation*. During testing, the TCAC will support quick-look analysis activity. The lead test analyst will be able to monitor critical SUT data in near real-time and make schedule change recommendations to the test director. All data feeds for the SUT, instrumentation, discrete events, and state data will be recorded. Some SUT and instrumentation data may be recorded at test sites, and forwarded to the TCAC after test completion.

e) *Post-test Analysis*. After testing is completed, test events can be replayed as necessary to support test objectives. For example, post-test analysis could compare position data from a variety of sources; determine the impact (if any) of network performance and reliability; and score and weight questionnaire responses.

More detail is contained in a TCAC design requirements document [43].

3.2.2.3 TCAC Description

a) *Location*. The TCAC is located in a 4-room secured suite on the 2nd floor of Bldg. 20140 at Kirtland AFB, NM.

b) *Internal Architecture*. The TCAC is reconfigurable, and will support a variety of network architectures. The TCAC internal configuration will also change as a function of the type of test activity going on. During early test rehearsal and training, the TCAC architecture will involve local nodes (workstations) representing test participants. In general, the TCAC will contain two large screen displays, a communications suite, work stations for a test director, chief test analyst, communications supervisor, and test operations manager. Detailed hardware descriptions can be found in the TCAC architectural design recommendations [39].

c) *Workstations.* Manning levels in the TCAC fluctuate depending on the type of activity being supported. Supported activity can range from test planning to test execution. A manpower/functional diagram supporting test execution is shown in Figure 3-1.

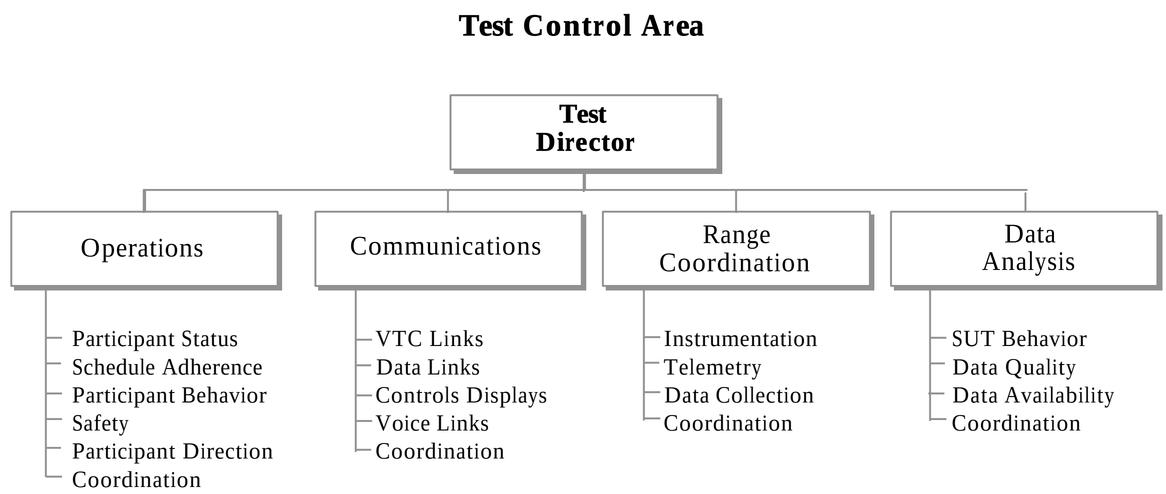


Figure 3-1. TCAC Functional Diagram

d) *Equipment*. In general, the TCAC has equipment to support operations as a control center and a DIS stealth node. The TCAC equipment can display, log, and analyze many types of data. TCAC communication equipment will support data, video, and voice communications. An equipment list is available upon request.

3.2.2.4 Specific Test Program TCAC Support

The TAPs for the SIT and ETE will include the details on test specific TCAC functions, responsibilities, and procedures.

3.2.2.5 Summary

Test and evaluation using distributed simulation assets offers promise as both a cost-saving tool and a test enhancement tool. Potentially, the use of networking can relieve the need for some duplication or transportation of equipment, and movement of personnel. Networking may also affordably add robustness to a test environment. However, none of the potential promises will be realized if distributed assets cannot be reliably controlled from the test's nerve center.

3.2.3 Issues, Objectives, and Measures

The issues for the JADS JT&E are derived from the program charter. This section lists the JADS issues and objectives, providing more detail on each along with a further decomposition into subobjectives and measures. Issues 2 and 3 concern the ADS components and procedures discussed in the previous section. Issue 1 relates to the test capability that ADS provides, and as previously mentioned, will be discussed in sections 3.3 and 3.4 for the specific test programs.

Issue 1: What is the present utility of ADS, including DIS, for T&E?

What can ADS technology do for T&E today? Can it support test planning, test rehearsal, test execution, and test evaluation in a cost-effective way? Is the cost of bringing ADS to T&E justified by increased returns in the quality of testing? Are acquisition decision risks reduced? The central focus of the JADS JT&E is on the kinds of utility and cost-effectiveness questions illustrated above. Currently the JADS JTF has only questions; answers lie in the future results of actual testing.

- Objective 1-1: Assess the validity of data from tests utilizing ADS, including DIS, during test execution.

  The focus of this objective is to analyze the validity of the data used to calculate performance and effectiveness measures in an ADS test environment. The performance data of the SUT using the ADS test method will be compared to the data using conventional test methods. Anomalies noted in this comparison will be investigated and reported on. SUT measures will be calculated, when possible, by SUT experts and evaluated by these experts for "realism." That is, these experts will answer questions such as: “Are the data adequate to support performance and effectiveness test issues and objectives,” and “Were the results as expected?”

  The measures that have been defined for this objective are the following:

  - Degree to which ADS provides valid SUT data.

  - Percentage of ADS data which are valid (data supporting test measures which are timely, accurate, reliable, and otherwise faithfully represent real world systems data).

  - Degree to which test participants were able to distinguish between simulated (virtual or constructive) and live assets.

  - Degree to which test actions were impacted due to the ability to distinguish between simulated and live assets.

- Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E.

  The benefits of incorporating ADS into T&E will be addressed in terms of the following subobjectives:

  - Subobjective 1-2-1: Assess ADS capability to support the early phases of the acquisition process.

The benefits of incorporating ADS into the early acquisition phase will be addressed in terms of improvements in requirements, cost effectiveness studies, cost trade-off studies, and early operational assessments as obtained from experts in those areas, given the results of Objective 1-1 (i.e. ADS's ability to produce valid data for T&E test execution). These early phases are those phases prior to engineering and manufacturing development (EMD).

The measures that have been defined for this objective are the following:

- Degree to which ADS can improve COEAs.

- Degree to which ADS can improve requirements development.

- Degree to which ADS can improve trade studies.

- Degree to which ADS can improve Early Operational Assessments.

- Percentage decrease/increase in cost during early acquisition phase due to ADS.

• Subobjective 1-2-2: Assess ADS capability to support T&E planning and test rehearsal.

The benefits of incorporating ADS into the T&E planning phase, to include test rehearsals will be addressed in terms of improvements to test concepts, test designs, test procedures, test preparations, and tactics development.

The measures that have been defined for this subobjective are the following:

- Degree to which test concept/design is improved by ADS.

- Degree to which pretest rehearsals of test/exercise control procedures using ADS improved test preparations.

- Degree to which pretest rehearsals of data management procedures using ADS improved test preparations.

- Degree to which pretest exercise of data reduction and analysis routines using ADS improved test preparations.

- Degree to which ADS can be used for tactics development prior to test execution.

- Percentage decrease/increase in test planning and rehearsal cost due to ADS.

- Subobjective 1-2-3: Assess ADS capability to support T&E execution.

  The benefits of incorporating ADS into the T&E execution phase will be addressed in terms of improvements to test realism, test statistical validity, safety, and reduced test time or cost.

  The measures that have been defined for this subobjective are the following:

  - Degree to which ADS can add assets to test execution.

  - Degree to which added ADS assets added value to the test (realism) beyond that available without the appropriate numbers or types of targets, threats, etc.

  - Degree to which ADS can increase test time, events, etc.

  - Degree to which ADS can test hazardous or unsafe conditions safely.

  - Degree to which ADS can be used to validate DT&E specification compliance (sooner or at less cost), e.g. using HWIL simulations.

  - Percentage decrease/increase in test execution cost due to ADS.

Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?

The enabling technologies for ADS have been available for some time. However, exploitation of practical T&E applications is in its infancy. Demonstrations have pointed the way and offered promises. Actual testing will place more rigorous demands upon consistency, reliability, fidelity, and validity than demonstrations. The T&E communities have been offered some proofs of principle through demonstrations, but the transition from demonstrations to practical applications will not be easy. One of the jobs of the JADS JTF, which flows naturally from Issue 1, is to identify the constraints and concerns that are surfaced when ADS is moved beyond training and demonstrations to real testing applications.

This issue is broken into three objectives. The first two objectives look at the constraints and concerns in the performance of ADS. The third objective looks at policies and procedures.

- Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E.

  This objective is broken down into three subobjectives as follows:

- Subobjective 2-1-1: Assess player instrumentation and interface performance constraints and concerns.

  This subobjective looks at constraints and concerns regarding player instrumentation and player interface hardware and software. The measures address these concerns for test instrumentation preparations both prior to testing and during testing, e.g., getting ready for the next trial. The existence of player data interchange standards will contribute substantially to performance, and a measure is used to present these data.

  The measure that has been defined for this subobjective is the following:

  - Degree to which live, virtual, and constructive players exist, can be instrumented, and can be readied for a test.

- Subobjective 2-1-2: Assess network and communications performance constraints and limitations.

  This subobjective focuses on the network and communications links between ADS players. Concerns exist, even now, about the availability of communications bandwidth to provide requisite fidelity of player actions and instrumentation parameters. And, even given the required bandwidth, there exist concerns regarding the availability of networks, i.e. those that exist appear to be heavily used and may subject users to unanticipated schedule delays.

  The measures that have been defined for this subobjective are the following:

  - Degree to which network systems are available for ADS use.

  - Percentage of ADS trials canceled or otherwise not used due to network problems.

  - Percentage of available bandwidth (average, peak) used by entity type.

  - Percentage of available bandwidth (average, peak) used by PDU type.

  - Percentage of time PDUs were received out of order by a network node.

  - Percentage of total PDUs required at a node that were delivered to that node.

  - Average and Peak data latency between ADS nodes.

- Subobjective 2-1-3: Assess the impact of ADS reliability, availability and maintainability on T&E.

This objective will examine the ability of the ADS systems (players and network) to be up and operating at scheduled test initialization and to remain up and operating throughout test duration. This operating reliability should provide the tester with an overall indication of the expected success rate for a given ADS test mission.

The measures that have been defined for this subobjective are the following:

- Percentage of trials delayed, rescheduled, and/or redone due to the ADS systems (exclusive of network) unavailability.

- Percentage of ADS trials delayed, rescheduled, and/or redone due to unavailability of planned networks (e.g. DSI).

- Percentage of trials in which network connection was lost long enough to require trial cancellation.

- Degree to which trial delays, reschedules, and redo's compare to real world delays, reschedules, and redo's due to weather, maintenance, etc.

- Mean operating time between ADS system failures (severe enough to require trial cancellation).

- Average down time due to ADS network failures.

• Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E.

This objective focuses on those parameters that are associated with implementation details of ADS for T&E applications. The parameters of highest interest, i.e. those associated with data management and with configuration management, have been identified in the following two subobjectives:

• Subobjective 2-2-1: Assess the critical constraints and concerns regarding ADS data management and analysis systems.

Since one of the basic purposes of a T&E is to collect data, it is important that data management systems exist that handle the distributed nature of ADS systems.

The measures that have been defined for this subobjective are the following:

- Degree to which ADS nodes provide for collection, data entry, and quality checking of pre and post-trial briefing data.

- Adequacy of relevant test data storage at ADS nodes.

- Adequacy of data translation systems at ADS nodes.

- Ease with which data can be retrieved, post-trial, from a given node.

• Subobjective 2-2-2: Assess the critical constraints and concerns regarding configuration management of ADS test assets.

Since the nature of ADS is such that protocols are being expanded, hardware and software is continuously being upgraded for improved fidelity, systems are being added, etc. it is important that systems exist that provide for configuration management. Test managers must be able to control the configuration of the systems and networks used for their tests.

The measures that have been defined for this subobjective are the following:

- Degree to which test managers can control the configurations of ADS participants, the ADS environment data, and ADS networks.

- Degree to which player data exchange standards exist and are adequate.

• Objective 2-3: Develop and assess methodologies associated with ADS for T&E.

Since ADS is a new tool that is being introduced into T&E, new methodologies that are being and will be developed need to be assessed. This development and assessment will be addressed in terms of the following subobjectives.

• Subobjective 2-3-1: Develop and assess methodologies associated with test planning for tests using ADS.

Methodologies will be developed and documented for test planning for tests using ADS under this subobjective. The effectiveness of these methodologies will be addressed in the first issue. No measures have been developed for this subobjective.

• Subobjective 2-3-2: Develop and assess methodologies associated with test execution and control for tests using ADS.

Methodologies will be developed and documented for test execution and control for tests using ADS under this subobjective. The following measures indicate the areas of test control and safety that are considered at this time to be concerns:

- Degree to which specialized rules of engagement are required for live, virtual, and constructive player mixes.

- Ease with which rule/constraint violations may be accomplished without detection.

- Degree to which protocols, processes and procedures are needed to enable effective, centralized, test control.

- Degree to which real-time analysis systems support test safety and other test control requirements.

• Subobjective 2-3-3: Develop and assess methodologies associated with data management and analysis for tests using ADS.

Methodologies will be developed and documented for data management and analysis for tests using ADS under this subobjective. The effectiveness of these methodologies will be addressed in the first issue. No measures have been developed for this subobjective.

• Subobjective 2-3-4: Develop and assess methodologies associated with verification, validation, and accreditation (VV&A) for tests using ADS.

Methodologies will be developed and documented for verification, validation, and accreditation (VV&A) for tests using ADS under this subobjective. The effectiveness of these methodologies will be addressed in the first issue. No measures have been developed for this subobjective.

Issue 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?

Issue 3 flows naturally from Issue 2. Once constraints and concerns are identified, the next logical step is to identify practical and affordable requirements and development efforts to remedy constraints or lessen concerns so that future support of T&E will be enhanced.

• Objective 3-1: Identify requirements for ADS systems that would provide a more complete T&E capability in the future.

This objective identifies future requirements that would expand the current capabilities of ADS for T&E. Areas of interest include: information exchange capabilities, network requirements, ADS player interface units, data capture devices, and management procedures.

3.3 SYSTEM INTEGRATION TEST

The System Integration Test (SIT) will evaluate the ability of ADS to complement and enhance the existing techniques for testing powered, guided weapons delivered against maneuvering targets. The evaluation will quantify the value added of ADS relative to current testing techniques.

3.3.1 Description

The SIT applies ADS to an air-to-air missile test program. The test will link live aircraft with ground simulators, including an air-to-air missile hardware-in-the-loop (HWIL) facility.

The SIT configuration has both DT&E and OT&E characteristics. There is a DT&E flavor because an HWIL facility is used to simulate the missile. This allows the detailed performance of missile subsystems to be monitored, typical of a DT&E test. The OT&E characteristics of the SIT result from the use of actual aircraft performing operationally realistic engagements. Of particular value is that the launch aircraft fire control radar operates in the real environment and is affected by weather, ECM, clutter, and other variables for which good digital models do not exist. This means that the test will be more representative of the performance of the integrated weapon system, instead of the weapon alone.

The AIM-120 Advanced Medium Range Air-to-Air Missile (AMRAAM) was selected for the test. The intent is to extend the SIT results as being representative of the broad class of precision guided munitions systems. Future missile programs which might benefit near-term include the AIM-9X, Joint Direct Attack Munition (JDAM), and Evolved Sea Sparrow Missile (ESSM).

3.3.1.1 Description of SUT (AMRAAM)

The AIM-120 AMRAAM is an all-weather, radar-guided air-to-air missile. It can intercept aggressively maneuvered targets from any aspect from low to high altitudes, under a variety of electronic combat conditions. The missile’s sophisticated targeting logic allows a single launch aircraft to simultaneously engage multiple targets with multiple missiles. The missile’s active seeker permits the launch aircraft to employ “launch and leave” tactics; i.e., maneuver after launch without the requirement to illuminate the target continuously until intercept. Employed by the F-14, F-15, F-16 and F/A-18, it will also be used by follow-on fighter aircraft.

The AMRAAM remains completely dormant until launch-initiate, when it quickly activates. After the missile separates from the launch aircraft, it can locate its target autonomously. On long range intercepts, it can use updated target information transmitted via the launch aircraft data link system to compute midcourse navigation corrections.

The AMRAAM system incorporates four guidance modes:

- Command update by data link from the launch aircraft at longer ranges with active terminal guidance.

- Inertial guidance with active terminal guidance if command update is not available.

- Active terminal guidance with no reliance on the aircraft fire control system (FCS) at ranges within the seeker's acquisition range.

- Active radar with home-on-jam (HOJ) during any phase of flight.

The AMRAAM system includes the missile, launcher (rail or eject), FCS and supporting avionics in the launching aircraft, and its aircrew.

3.3.1.2 Test Concept

The SIT involves a live launch aircraft simulating a missile launch against a live, manned target aircraft. ADS techniques will be used to link the live aircraft to an HWIL simulation representing the missile, allowing a test in which neither the missile nor a target drone is expended. Progressively more complex scenarios will be flown to investigate the characteristics of ADS-based tests. The SIT will be implemented in two phases.

In Phase 1, the two live aircraft and the HWIL simulation are located at the same test range at Eglin AFB, FL. The test will focus on TSPI requirements, accuracy, and characteristics of the signals needed to drive the HWIL simulation with minimal latency.

In Phase 2, the live aircraft are located on one test range at Pt. Mugu, CA, and the HWIL simulation is geographically remote, remaining at Eglin AFB. Complexity of the scenarios will be increased by adding a manned flight simulator at China Lake, CA to the ADS network linking the locations. This phase will address issues associated with long-haul networking of data in real time, test coordination, networking of facilities using different range data formats and protocols, and multi-service issues.

All scenarios will involve one aircraft engaging a target aircraft and launching a simulated AMRAAM missile. The HWIL simulator will model the missile flyout in response to target maneuvers by using actual cueing and data link information from the airborne launch aircraft and will provide a measure of the miss distance between the missile and the target. The HWIL simulator will also provide diagnostics to monitor the performance of the missile subsystems during the engagement.

3.3.2 Issues, Objectives, And Measures

Results of the SIT will be used to collect data on all three JADS issues.

3.3.2.1 Issue 1: Utility of ADS for T&E

- Objective 1-1: Assess the validity of data from tests utilizing ADS, including DIS, during test execution.

Under this objective, the SIT will assess the validity of AMRAAM data generated in the SIT ADS configuration. Depending on the nature of the AMRAAM data being assessed, this will be measured by either determining the degree to which the SIT provides valid AMRAAM data or by calculating the percentage of AMRAAM measures for which adequate data can be collected. This assessment will rely on evaluation of the data by analysts from the AMRAAM test program working together with the JADS analysts.

The types of data to be gathered in the SIT are the same in each engagement between the launch and target aircraft: AMRAAM initialization, data link, and terminal guidance performance; AMRAAM subsystem performance; position versus time for the target and the AMRAAM; and relative geometry between AMRAAM and target at time of intercept. These data are analyzed to determine the miss distance for the missile and can be used in off-line lethality models to determine P_K.

The data set and related analysis allows either DT&E objectives (where the detailed subsystem performance is assessed) or OT&E objectives (where P_K is the "bottom line") to be addressed. The following subset of AMRAAM DT&E and OT&E objectives will be evaluated in the SIT (objective numbering is from the AMRAAM TEMP):

DT&E Objectives:

Subobjective 1.1. Evaluate AMRAAM performance against fighter-sized targets in representative operational environments.

Subobjective 1.6. Assess the all-aspect launch capability of AMRAAM in representative operational environments.

Subobjective 1.7. Assess AMRAAM performance in lookdown/shootdown scenarios, over water and over land.

Subobjective 1.8.1. Evaluate initialization, data link, and terminal guidance in the presence of a single self-screening jamming (SSJ) target.

Subobjective 1.8.4. Evaluate initialization, data link, and terminal guidance in the presence of multiple SSJ formations.

Objective 11. Assess AMRAAM performance against clustered targets.

FOT&E Objectives:

Objective E-1. Evaluate AMRAAM weapon system capability in multiple target engagements.

Objective E-2. Evaluate AMRAAM weapon system capability against targets in lookdown/shootdown scenarios.

Objective E-3. Evaluate AMRAAM weapon system capability against targets protected by ECM.

Objective E-5. Evaluate AMRAAM weapon system capability against all aspect and maneuvering targets.

OT-IIIB Objective:

Assess the capability of the AMRAAM to target individual threat aircraft resolved by the launch aircraft.

These objectives will be evaluated by varying the details of the SIT engagements. When common objectives are combined, the following variable engagement features result for the SIT missions:

- Lookdown/shootdown scenarios, over water and over land (DT&E & OT&E).

- Various target aspects (DT&E & OT&E).

- Maneuvering targets (OT&E).

- Multiple resolved targets (DT&E & OT&E).

- ECM involving SSJ on single or multiple targets (DT&E & OT&E).

• Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E.

  This objective will assess the benefits of the SIT configuration as compared to the other major air-to-air missile testing techniques, including live fire, captive carry, and stand-alone simulators. The subobjectives will be addressed in the SIT as follows:

  • Subobjective 1-2-1: Assess ADS capability to support the early phases of the acquisition process.

SIT data will not be used directly to address this subobjective.

- Subobjective 1-2-2: Assess ADS capability to support T&E planning and test rehearsal.

  There are two approaches for addressing this subobjective through the SIT. First, the SIT concept itself can be viewed as an application of ADS to support the planning and rehearsal of live fire missile tests. Secondly, ADS techniques can be used during the build up of the SIT for planning and rehearsal of the SIT live missions.

  Regarding the first approach, execution of the SIT live missions will be assessed to determine the degree to which they could have improved the corresponding live fire tests.

  Regarding the second approach, the SIT is investigating the utility, feasibility, and value added of using the linked Guided Weapons Evaluation Facility (GWEF) - Preflight Integration of Munitions and Electronics Systems (PRIMES) configuration for rehearsal of the SIT missions. Alternate ADS configurations are also being considered, such as linking manned flight simulators and digital models. The configurations would be used to exercise the SIT data collection systems and to check out the linkage between the aircraft and the AMRAAM simulation in the GWEF. Other potential uses of the configurations include refinement of the flight test profiles to be executed during the live missions.

- Subobjective 1-2-3: Assess ADS capability to support T&E execution.

  AMRAAM test personnel will be interviewed with regard to the realism of the ADS-enhanced test as compared to an actual all live player test event. The capability of the SIT configuration to allow engagement scenarios to be tested which are restricted in live fire tests (because of safety or drone performance restrictions) will be assessed. The ability of the SIT to collect adequate data for the listed AMRAAM DT&E measures, along with questionnaires to the AMRAAM DT&E community, will help in answering this subobjective. Also, cost data will be collected for both the ADS-enhanced test event and what a similar test would cost using all live assets. This cost data, along with how well ADS can replicate actual test events, will be combined for the cost/benefit analysis of ADS.

3.3.2.2 Issue 2: Constraints, Concerns, & Methodologies When Using ADS

The SIT will evaluate the utility of using ADS techniques for testing an air-to-air missile system in operationally realistic scenarios. Part of this evaluation will address the ability of the ADS techniques to support stringent constraints derived from interfacing live aircraft with an HWIL facility in a manner adequate to support T&E. These include requirements for time-space-position information (TSPI) accuracy, reference frame alignment, synchronization, and latency:

a) *TSPI Accuracy*. TSPI data from the launch and target aircraft will be used to drive the missile HWIL simulation. Proper response of the simulation will require a TSPI precision which pushes the limit of the best TSPI systems currently available. The SIT will evaluate different methods of providing such highly accurate TSPI data.

b) *Reference Frame Alignment*. TSPI data from the launch and target aircraft must also be accurately aligned to the reference frame of the missile in the HWIL facility. This requires careful coordinate transformations and time alignment. The SIT will evaluate the ability to align TSPI data to the accuracy required by the missile HWIL simulation.

c) *Synchronization*. Data from the various entities must be carefully synchronized. The data are time stamped when generated and then put onto the network when the network is ready to accept the information. Several pieces of information which were generated simultaneously will be received sequentially. Also, data generated at any given time may be received out of time sequence with other related data. The receiving node must have a way of resynchronizing the information it needs to perform its function. The SIT will examine these issues.

d) *Latency*. A future desired application of ADS is to allow "closing the loop" between the missile and the target aircraft. This would allow evaluation of reactive countermeasures and certain ECM techniques. Delays in processing and passing information through the ADS network, referred to as latency, may have a major impact on the validity of any results obtained in this fashion. The SIT will identify and quantify contributions to total latency.

3.3.2.3 Issue 3: Requirements & Recommendations

Lessons learned from the SIT will roll up into lessons learned from all other JADS test activities to form overall recommendations which enable ADS to provide a more complete T&E capability in the future. Specific requirements for ADS-enhanced testing of advanced missile systems will be quantified, especially in terms of TSPI accuracy, reference frame alignment, synchronization, and latency (see Issue 2 discussion above).

3.3.3 Test Activities

The SIT test scenarios will be similar to completed AMRAAM flight tests and will acquire all the same types of AMRAAM system data as in the live tests. Major features of the AMRAAM operational concept discussed above have been incorporated into the test configurations. This test consists of two phases which are described below. The primary difference between these phases is in their respective network configurations linking the players: Phase 1 uses a local area network (LAN) for player linking, and Phase 2 integrates geographically separated LANs with a wide area network (WAN).

3.3.3.1 Phase 1

a) *Purpose*. The purpose of Phase 1 is to establish and operate an ADS LAN configuration linking live aircraft with an HWIL air-to-air missile simulation and to evaluate the T&E utility of this configuration. The linking is to be implemented with minimal latency, with near real-time being the goal (near real-time as defined by the Range Commanders Council is a latency of 2 seconds or less), so that the simulated scenario lags the real aircraft by 2 seconds or less. The use of ADS for test planning and rehearsal will also be explored in this phase. All players in Phase 1 are located at the same installation.

   Phase 1 will evaluate the AMRAAM DT&E and OT&E objectives listed in Section 3.2.2.1 involving a single target. The following engagement features will be used in the Phase 1 missions:

   - Lookdown/shootdown scenarios, over water and over land (DT&E & OT&E).

   - Various target aspects (DT&E & OT&E).

   - Maneuvering targets (OT&E).

   - ECM involving SSJ on a single target (DT&E & OT&E).

b) *Test Scenario*. The Phase 1 test configuration is illustrated in Figure 3-2. A live launch aircraft flies against a live maneuvering target aircraft at the Eglin Gulf Test Range. Global Positioning System (GPS)-aided TSPI and telemetry data are down linked from the aircraft and passed to the Central Control Facility (CCF) at Eglin. The new ADS feature of this test would be a link to the GWEF where an AMRAAM HWIL simulation is located (i.e., MISILAB). Unlike a live fire test in which an AMRAAM is actually launched at a drone target, data from the launch aircraft are used to initiate a simulated launch of the AMRAAM in the GWEF. After the simulated launch, data link messages from the launch aircraft (which update the live target location and motion) are provided to the MISILAB for the AMRAAM hardware to use in its guidance algorithms during the simulated flyout to the target aircraft. The GWEF also uses the live target TSPI data to dynamically control the representation of the target in the radio frequency (RF) scene presented to the AMRAAM seeker in the MISILAB's Radio Frequency Target Simulator (RFTS). As the AMRAAM undergoes its simulated flyout, its trajectory information (position versus time) is passed back from the GWEF to the CCF for display to test operators and analysts.

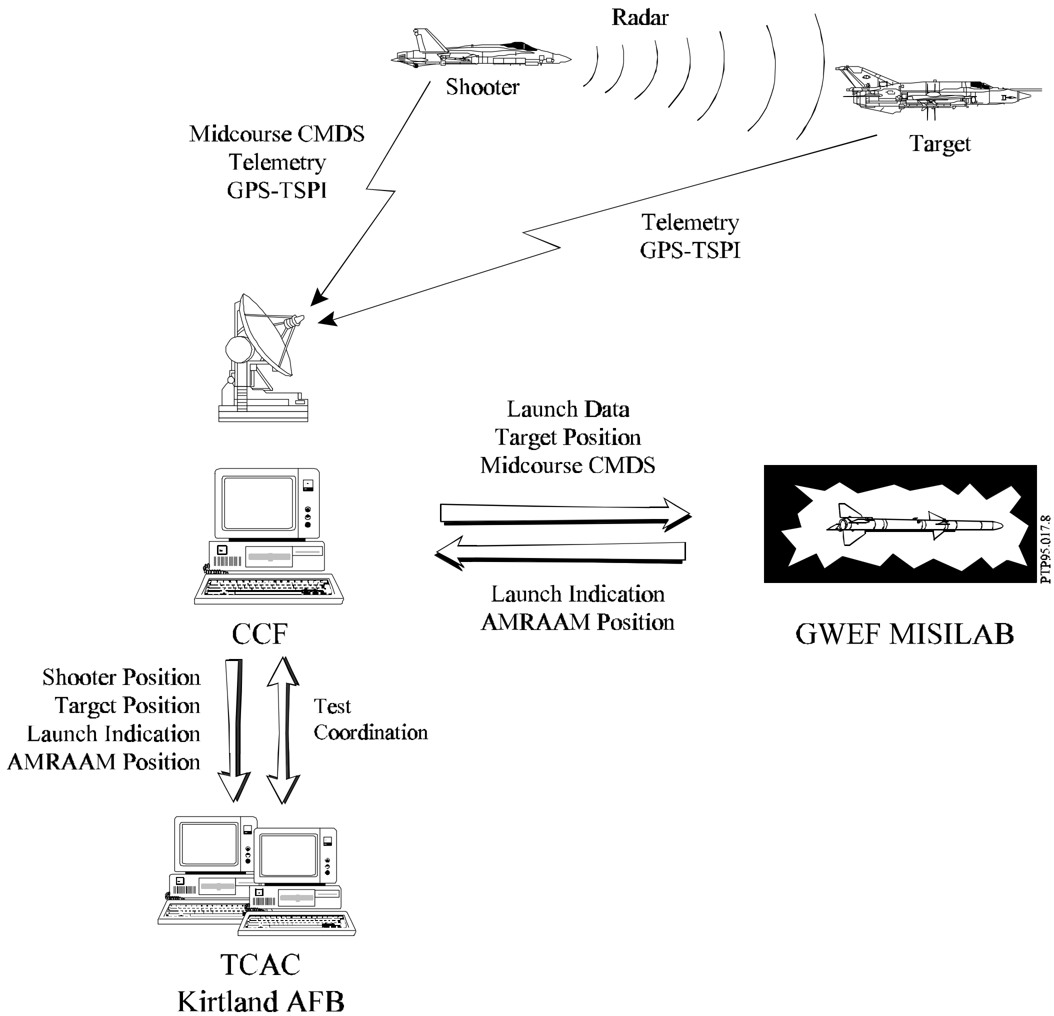


Figure 3-2. System Integration Test Configuration-Phase 1

In some of the simulated engagements, an ECM pod will be added to the target aircraft to test jamming/degradation of the launch aircraft fire control radar and data link messages.

The CCF will also be linked to the TCAC, and the link will be used to pass entity state PDUs for the three players. The PDUs will be processed at the TCAC to provide JADS analysts at Kirtland AFB with near real-time stealth node viewing of the simulated engagement occurring at Eglin AFB. In addition, the CCF-TCAC link will be used to coordinate the live missions. Coordination procedures will be developed and listed in the SIT Phase 1 TAP.

c) *ADS Configuration*. There are three players in this test scenario; a launch aircraft, a target aircraft, and an AMRAAM. The launch and target aircraft are live. The prelaunch and launch representation of the AMRAAM is by either an AMRAAM Captive Equipment (ACE) pod or by an Integrated Test Vehicle (ITV) carried by the launch aircraft. The postlaunch representation of the AMRAAM is by the HWIL simulation in the GWEF.

The network hardware diagram for Phase 1 is shown in Figure 3-3. Major features of this figure are as follows:

- Multi-object Tracking and Control System (MTACS) provides the data link and processing for GPS pod data.

- The TSPI Data Processor (TDP) combines TSPI data from various sources (GPS pods, range TSPI data, and aircraft Inertial Navigation System (INS) data) for more accurate TSPI determinations.

- The Fiber Distributed Data Interface (FDDI) LAN provides high bandwidth connections between the various CCF hardware systems.

- The CCF DEC ALPHA merges and formats the various data sources for transmission to the GWEF via the router.

- Data passed between the CCF and the GWEF will be encrypted using KG-95 encrypters.

- The MISILAB DEC ALPHA receives the data from the CCF and stores it until needed by MISILAB subsystems.

- The SCRAMNET Loop is a LAN providing high bandwidth connections between various MISILAB hardware systems.

- The Adaptive Data Collection Unit (ADCU) handles AMRAAM telemetry data from the MISILAB HWIL simulation.

- The Simulation Engagement Display System (SEDS) provides a real-time display of the simulated AMRAAM engagement of the target.

- The Engagement Dynamics System (EDS) generates the scenarios run in the MISILAB and controls the AMRAAM hardware, RF scene generation, and Flight Motion Simulator (the 3-degree of freedom table upon which the AMRAAM seeker is located).

- The Advanced Aircraft Simulation Interface (AASI) allows the umbilical and rear data link messages from the live shooter aircraft to be interfaced to the AMRAAM hardware in the MISILAB.

- The Government Simulation Hardware (GSH) test station residing in the MISILAB (GSH-A) contains actual AMRAAM hardware, missile RF data link receiver and processor hardware, a fin digital simulation, and an inertial reference unit simulator.

- The RF Control System (RFCS) controls the generation of the RF scene in the RFTS viewed by the AMRAAM seeker.

- The TCAC will be used to remotely monitor data collected in the test and to establish voice communications with the CCF at Eglin. Data will be collected on procedures for test coordination from a remotely located central site (i.e., the TCAC). As Figure 3-3 shows, the CCF DEC ALPHA provides the data interface for the CCF-TCAC link.

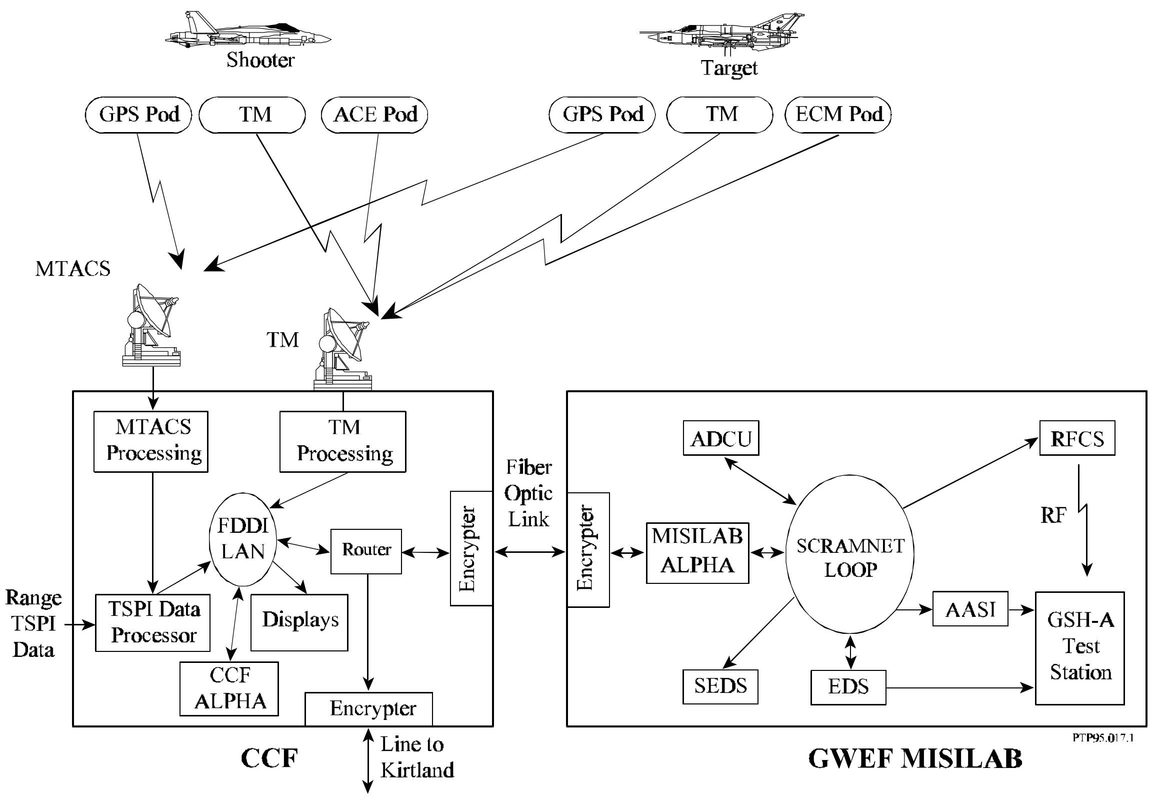


Figure 3-3. Phase 1 Network Hardware Diagram

The network information diagram for Phase 1 is shown in Figure 3-4. The live aircraft transmit state and telemetry (TM) data to the CCF using range data formats. The CCF processes these data and uses them to provide inputs to the AMRAAM HWIL simulation located in the GWEF MISILAB. As the AMRAAM HWIL simulation is run, data on the simulated missile launch and flyout are transmitted to the CCF for display and recording. Entity state (ES) PDUs will be used for player state data exchanged between the CCF and the MISILAB and between the CCF and the TCAC. The AMRAAM launch indication will be provided by a fire PDU generated in the MISILAB. Coordination of the test between the CCF and the TCAC will be done via voice communications.

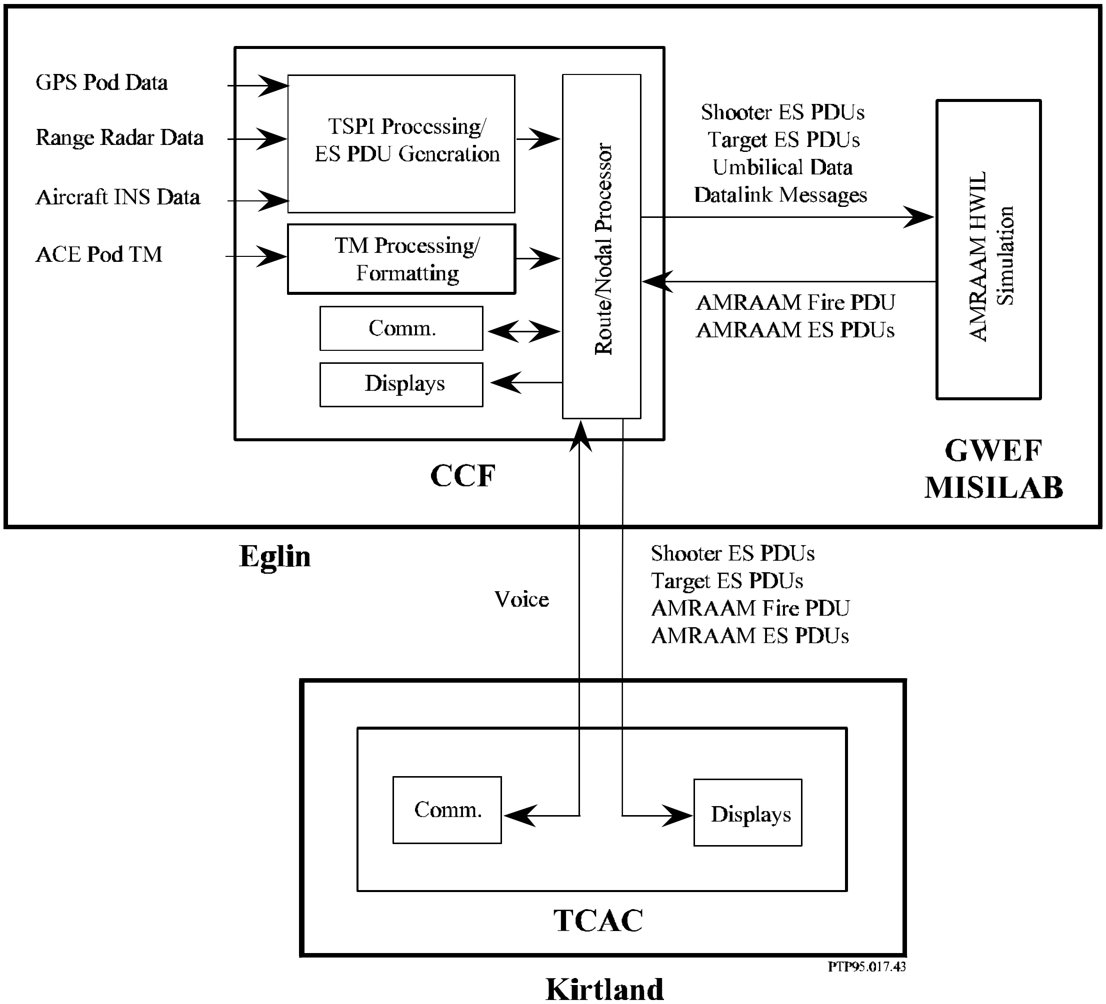


Figure 3-4. Phase 1 Network Information Diagram

As Figure 3-3 shows, the interfaces between the live players (shooter and target aircraft) and the virtual player (AMRAAM HWIL simulation) are not single "black boxes." Rather, there are several processing and hardware steps between the live and virtual players which depend on the type of data being passed. The major features of the interfaces are as follow:

- Live shooter to virtual missile interface for umbilical and data link messages: These data are generated by the FCS of the shooter aircraft and are downlinked to the CCF. After processing in the CCF, this data stream is passed to the MISILAB ALPHA and then interfaced to the GSH-A AMRAAM hardware via the AASI.

- Live target to virtual missile interface for TSPI data: The TSPI data from the GPS pods and the aircraft INS are combined with range TSPI data in the TDPs. The TDP output for the launch and target aircraft TSPI is passed to the GWEF MISILAB where it is used as input to the EDS and the target RF scene generation via the RFCS.

d) *Test Participant Roles*. Phase 1 of the SIT will be accomplished in a joint effort by the JADS JTF and the Air Force Development Test Center (AFDTC), AMRAAM Joint System Program Office (JSPO), and Range Applications Joint Program Office (RAJPO) at Eglin AFB. The roles of each are as follows:

JADS JTF

- Overall responsibility for the planning, execution, analysis, and reporting of the test.

- Develops ADS measures and related data elements.

- Analyzes and evaluates ADS measures.

- Integrates TCAC with CCF and operates TCAC during tests.

- Reports interim and final results to OSD.

AFDTC

The Eglin Gulf Test Range and facilities (CCF, GWEF, PRIMES, etc.) are under the control of AFDTC. In Phase 1, AFDTC:

- Develops the Phase 1 Integration Test Plan, including a description of the GWEF-CCF interface.

- Provides detailed test requirements to the JADS JTF.

- Identifies the operational issues to be evaluated.

- Develops and executes the V&V plan for the GWEF-CCF modifications.

- Provides flight test technical advice.

- Interfaces with the AMRAAM JSPO.

- Schedules/provides test assets.

- Provides CCF support.

- Provides and operates GWEF missile HWIL facilities.

- Plans and conducts the flight tests.
- Collects flight test data.
- Displays test engagement in the CCF.
- Analyzes test data and prepares the quick-look reports on the live missions and the final report.

AMRAAM JSPO

- Provides the AASI.
- Determines security requirements for AMRAAM data generated in SIT.
- Provides access to data from previous, comparable AMRAAM tests.

RAJPO

- Provides technical advice on the use of the GPS-aided TSPI pods.
- Provides software for converting RAJPO pod TSPI data into entity state DIS PDUs, Live Entity Broker (LEB), and for viewing the PDUs in the TCAC, Live Entity VisualizeR (LEVR).

e) The schedule of top level tasks and activities for Phase 1 is given if Figure 3-5. The schedule also shows the relative timing for Phases 1 and 2. The following Phase 1 tasks and activities are indicated in the schedule (see the TAP for a more detailed Phase 1 schedule):

Task 1.1 AASI Procurement: The AASI allows the launch aircraft umbilical and data link messages to be interfaced to the AMRAAM hardware in the GWEF in near real-time. Procurement of the AASI is to be directed and funded by the AMRAAM JSPO.

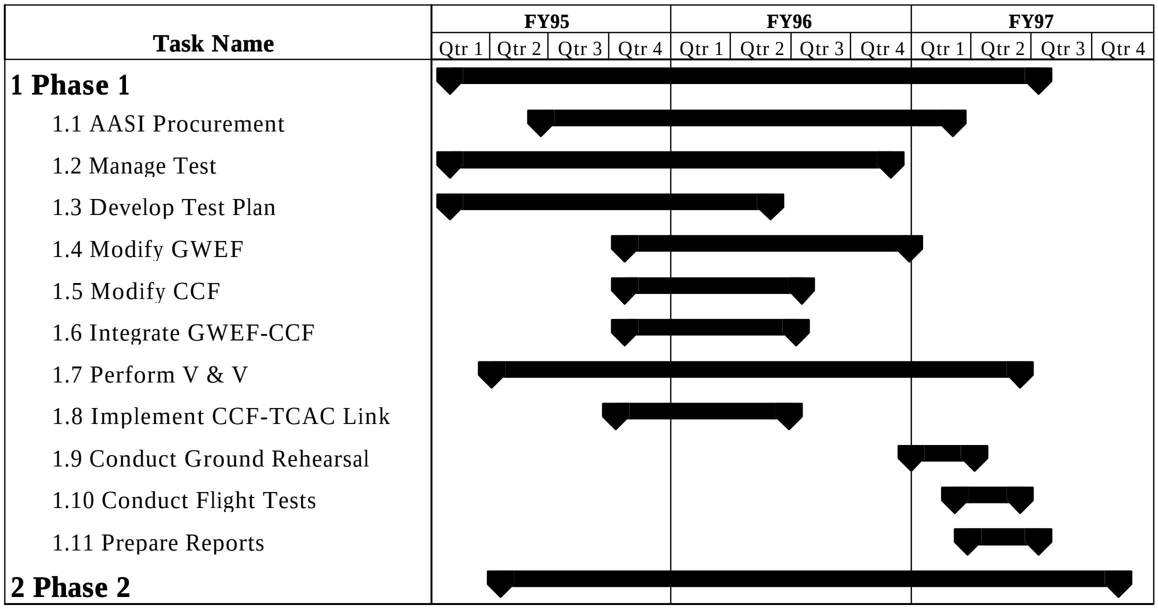


Figure 3-5. SIT Phase 1 Activities and Schedule

Task 1.2 Define Test: Identify all components involved in the test (i.e., GWEF, CCF, etc.) and define their roles. Data requirements and operational issues will be fully defined. The product will be an interface control document which will provide the details required for interfacing the CCF computers with the HWIL simulation in the GWEF. Joint JADS/AFDTC task.

Task 1.3 Develop Test Plan: From the detailed test scenario descriptions, develop an integration test plan which details the Phase 1 test buildup. Milestones and the steps to achieving each milestone will be described in this plan. Coordinate all technical activity and provide status reports to the JADS program office. Joint JADS/AFDTC task.

Task 1.4 Modify GWEF: Develop and implement software modifications to the GWEF simulation which allow the GWEF RF scene (RFTS) to dynamically respond to the live target aircraft maneuvers. This task will end with verification of the software modifications. AFDTC task.

Task 1.5 Modify CCF: Develop and implement hardware and software modifications required to merge and format the data down linked from the two live aircraft and to use these data to prepare dynamic RF scene inputs for the GWEF in near real-time. Software modifications needed to allow the display of real-time data on the CCF computer terminals. Modifications of the TSPI Data Processors needed to support real-time operations. AFDTC task.

Task 1.6 Integrate GWEF-CCF: Develop and implement hardware and software required to interface the modified CCF computers with the GWEF. This task will end with a test of the CCF-GWEF link to verify that mock scenario data are successfully being transferred. AFDTC task.

Task 1.7 Perform V&V: Perform verification and validation (V&V) of the GWEF-CCF modifications. The V&V approach to be used will involve comparing results from the SIT ADS configuration to results from live fire missions. Joint JADS/AFDTC task.

Task 1.8 Implement CCF-TCAC Link: Define data content and formats needed for link. Identify interface hardware and software. Install equipment and checkout entire link, including data processing and displays in TCAC.

Task 1.9 Conduct Ground Rehearsal: Use linked simulators and/or digital simulations to refine flight test plans and identify problem areas before the flight tests. Joint JADS/AFDTC task.

Task 1.10 Conduct Flight Tests: Includes three flight missions. The first mission will be run as a developmental mission to validate the test hardware, software, and concept. Data analysis is also included in this task. Data will be analyzed in the same manner as for live AMRAAM tests to evaluate the utility of the JADS configuration to support T&E (i.e., to evaluate the ability of the JADS data to support evaluation of the AMRAAM system MOEs/MOPs). Joint JADS/AFDTC task.

Task 1.11 Prepare Reports: Prepare a report for each Phase 1 flight mission, including work accomplished, lessons learned, and conclusions and/or recommendations, as appropriate. Joint JADS/AFDTC task.

3.3.3.2 Phase 2

a) *Purpose*. The purpose of Phase 2 is to establish an ADS WAN configuration linking live and simulated aircraft with an HWIL air-to-air missile simulation and to evaluate the T&E utility of this configuration. The network architecture will be designed to minimize latency, with near real-time being the goal. The live and virtual players in Phase 2 are located at geographically separated ranges.

Phase 2 will evaluate the AMRAAM DT&E and OT&E objectives listed in Section 3.2.2.1 involving multiple resolved targets, as well as those evaluated in Phase 1. The following engagement features will be used in the Phase 2 missions:

- Lookdown/shootdown scenarios, over water and over land (DT&E & OT&E).

- Various target aspects (DT&E & OT&E).

- Maneuvering targets (OT&E).

- Multiple resolved targets (DT&E & OT&E).

- ECM involving SSJ on single or multiple targets (DT&E & OT&E).

b) *Test Scenario*. In the second phase, the live aircraft will be located on the Sea Test Range at NAWCWPNS Pt. Mugu, rather than the Gulf Test Range at Eglin AFB, but will still be linked to the AMRAAM HWIL simulation in the GWEF at Eglin AFB via Kirtland AFB (see Figure 3-6). The value of linking such widely separated ranges is that the most cost effective combination of live and virtual facilities can be used by T&E users in a particular test, based on the type of system under test and the type of T&E activity.

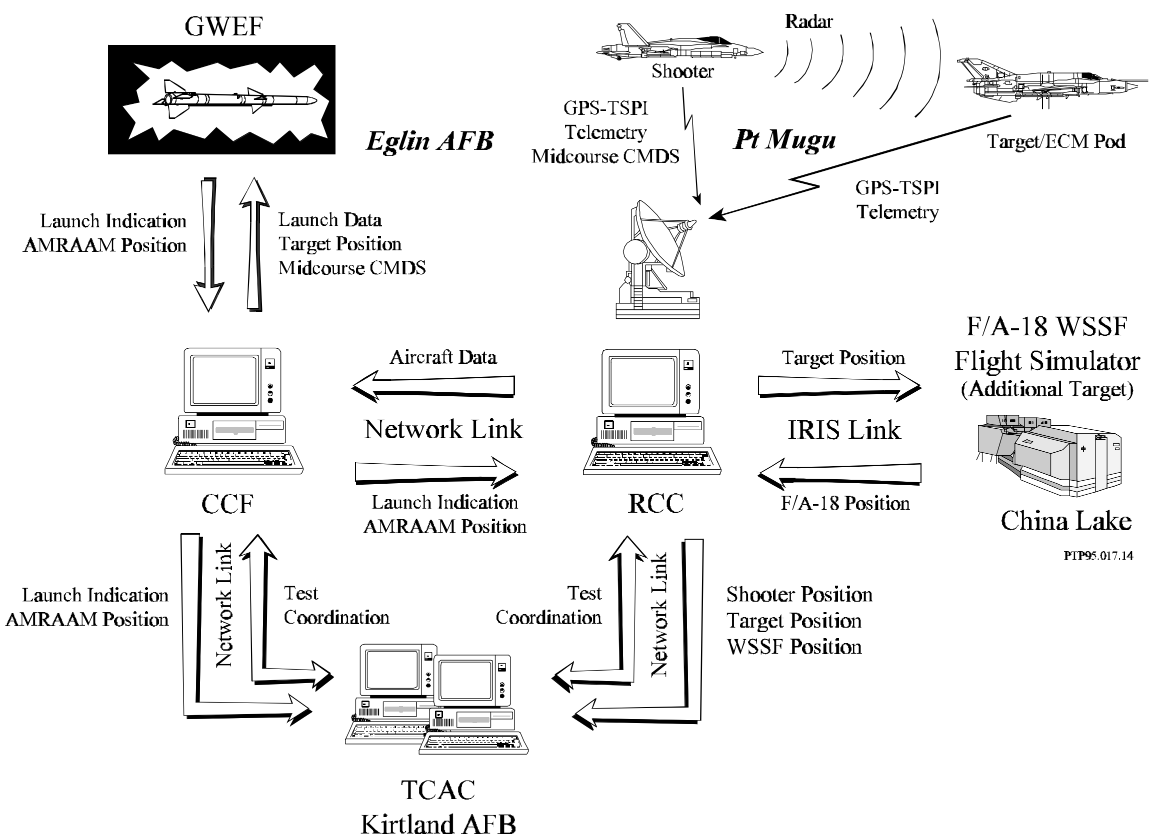


Figure 3-6. System Integration Test Scenario-Phase 2

An additional feature in the Phase 2 scenarios will be the linking of the F/A-18 Weapon System Support Facility (WSSF) manned flight simulator located at NAWCWPNS China Lake to the GWEF via the Pt. Mugu Range Control Center (RCC) (linking of the WSSF to the RCC will be provided by the Internetted Range Interactive Simulations (IRIS) program). The WSSF will be used to drive the representation of one of the additional threat targets added to the GWEF RF scene (in the MISILAB's RFTS), resulting in a more realistic maneuvering additional target representation (the WSSF pilot will follow the live target by "flying in formation" as a wingman). The WSSF may also be used to support planning and rehearsal of the Phase 2 test flights; details will be worked out during the Phase 2 test planning activity.

Also, the Phase 2 scenarios will make more extensive use of ECM pods on the target aircraft than was done in Phase 1. Details of these scenarios have not been finalized, but may include additional live target aircraft carrying ECM pods.

Both the CCF and the RCC will be linked to the TCAC (the network link between the CCF and the RCC will pass through Kirtland AFB). The RCC-TCAC link will be used to pass entity state PDUs for the live and simulated aircraft and the CCF-TCAC link to pass fire and entity state PDUs for the AMRAAM. The PDUs will be processed at the TCAC to provide JADS analysts at Kirtland AFB with near real-time stealth node viewing of the simulated engagement. In addition, the RCC-TCAC and CCF-TCAC links will be used to coordinate the live missions and the operation of the GWEF MISILAB. Coordination procedures will be developed and listed in the SIT Phase 2 TAP.

c) *ADS Configuration*. There are four players in this test scenario: a launch aircraft, a target aircraft, a target wingman aircraft, and an AMRAAM. As shown in Figure 3-6, the launch and target aircraft are represented by live manned aircraft. The target wingman aircraft is represented by a manned flight simulator. The prelaunch and launch representation of the AMRAAM is by either an ACE pod or by an ITV. The postlaunch representation of the AMRAAM is by the HWIL simulation in the GWEF.

The Pt. Mugu network hardware diagram for Phase 2 is shown in Figure 3-7. Major features of this figure are as follows:

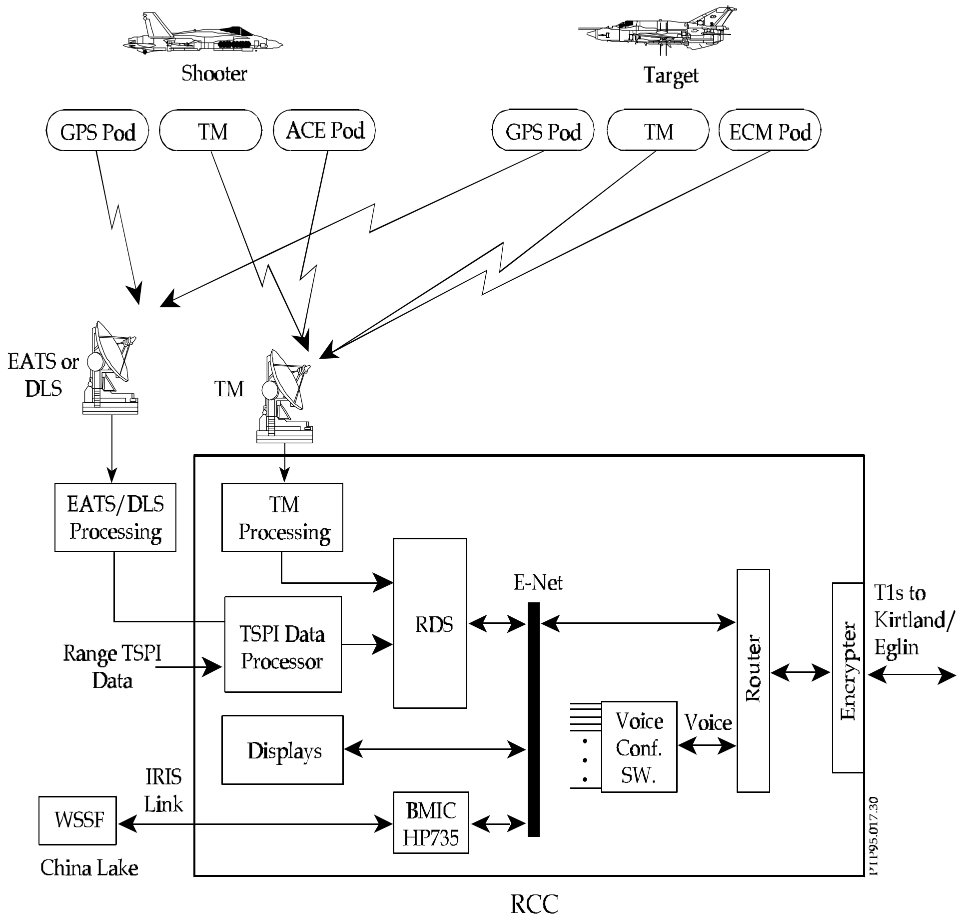


Figure 3-7. Phase 2 Network Hardware Diagram-Pt. Mugu

- The WSSF at China Lake is connected to Pt. Mugu's real-time computing facilities via IRIS computers and communications lines. The connection to the Pt. Mugu computers is via an HP735 computer in the Battle Management Interoperability Center (BMIC).

- Either the Extended Area Tracking System (EATS) or the GPS Data Link System (DLS) will provide the data link and processing for GPS pod data.

- The TDP will be located at Pt. Mugu for Phase 2 and will combine the same types of TSPI data as in Phase 1.

- Data processing will be provided by the Real-time Data System (RDS) computers.

- The Ethernet (E-Net) LAN provides high bandwidth connections between the various RCC hardware systems.

- The router handles protocol conversion for real-time computers and multiplexes telemetry, entity state PDU, and voice output into one or more T1 streams for transmission to Eglin via Kirtland.

- Data is encrypted before being transmitted from Pt. Mugu to Eglin and Kirtland.

- The TCAC will be used to remotely monitor data collected in the test, to monitor network performance, and to establish voice communications with the RCC. Data will be collected on procedures for test coordination from a remotely located central site (i.e., the TCAC).

The Eglin AFB network hardware diagram for Phase 2 is shown in Figure 3-8. Major features of this figure are as follows:

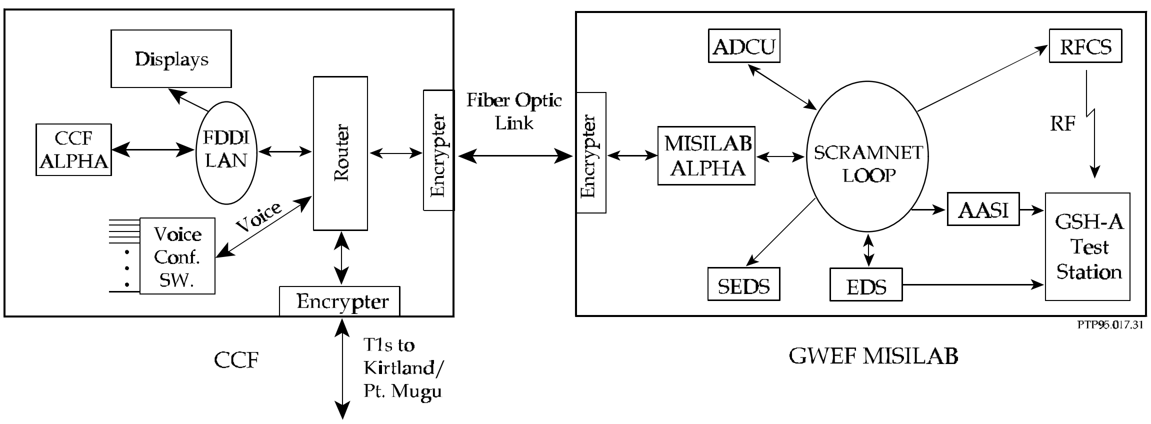


Figure 3-8. Phase 2 Network Hardware Diagram-Eglin

- The long haul network link interface equipment at Eglin AFB is similar to that at Pt. Mugu. A router will perform the de-multiplexing of data into individual streams and pass the appropriate data to the MISILAB.

- The link between the CCF and the MISILAB, and the configuration of the MISILAB, is the same as in Phase 1.

- The TCAC will be used to remotely monitor data collected in the test, to monitor network performance, and to establish voice communications with the CCF. Data will be collected on procedures for test coordination from a remotely located central site (i.e., the TCAC).

The network information diagram for Phase 2 is shown in Figure 3-9. The communications architecture is a direct connection between Pt. Mugu and Eglin, linking real-time computers, telemetry processing, and voice conferencing systems over multiplexed T1 lines. Communications over the network link between computers will comply with Range Commanders Council DR-19 protocols, while telemetry links will not use a communications